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GENERAL SIR WILLIAM J. CODRINGTON, G.C.B., in the Chair.

"ON THE EDUCATION OF STAFF OFFICERS."

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BLUE books are not usually supposed to afford very attractive reading, but I confess that, when their subject is of interest, I always feel some satisfaction in wading through them, because of the assurance they convey that the very latest and best information has been collected for digestion by their readers.

While engaged in reading three such volumes, presented to Parliament about a month ago, by the Royal Commission on Military Education, I was invited by the Council of the Royal United Service Institution to prepare a lecture for delivery in this theatre, and it occurred to me that "the education of Staff Officers" might possibly prove to be a subject of interest to this meeting.

The education of Staff Officers was formerly left very much to chance, or to be picked up during active service in the field, which, if available, is undoubtedly the best of staff schools; but when the operations of war began to be carried on with greater rapidity and with larger bodies of troops, the need of some previous knowledge on the part of Generals and Staff Officers was felt to be most urgent. War became more the subject of scientific study under such commanders and writers as the Archduke Charles, Jonimi, and Napoleon; but I cannot ascertain that any attempt was made to form a staff school until England set the example with her Senior Department, which was soon copied by most of the continental nations.

If we think over the great variety and vast importance of the duties which fall to the lot of the General Staff with an Army in the field, we must be lost in wonder that such duties are ever properly fulfilled, and, granting that a Staff Officer, like a poet, should be "to the manner born," we should surely spare no pains with his education, in order that native talent may be developed to its utmost limit.

The following translation from a French writer gives an admirable epitome of life on the staff in campaign, and though its language may seem somewhat high-flown, any one who has experienced the delightful sensation of responsibility involved in helping to carry out his General's plans, will pardon the high colouring of such a passage even when it appears in its English dress.

After describing the employment of infantry, cavalry, and artillery in action, the writer proceeds as follows:—

"What are the duties of the Staff Officer? his hands, it is true, are "void of trophies, his lips are not blackened by gunpowder, and the "sword which hangs at his side has rested in its scabbard perhaps all "through the action; but he has been seen at daybreak among the "skirmishers engaged in drawing a rapid sketch of the enemy's "position.

"He has been observed guiding the columns of attack through "storms of shot, and clouds of smoke upon points indicated by his "General for their onset. He has been seen sitting motionless on his "horse to serve, at once, as a point of formation for the line of battle, "and as a target for the enemy's fire. He has re-appeared after charges "of cavalry, he has placed an ambush, he has led the way on that "détour by which the retreat of a vanquished enemy has been "cut off.

"In the camp at nightfall silence succeeds the tumult, fatigue and "darkness have stopped the work of destruction, and the troops are "reposing after their exertions.

"Physical force is asleep, but thought still watches; the General "and his Staff are at work, counting the losses of the day, and pre-"paring resources for the morrow; here a Staff Officer records feats "of arms, and the names of those who will be proclaimed as heroes; "there, another traces a map which will prove interesting to the future "historian; a third combines numerous details into the general orders "of the day; while a fourth sets out to communicate, *vivâ voce*, the "most secret instructions, or to make enquiries on the part of his "General at the hospital, the magazine, or the stores.

"Before daylight you may distinguish, by the glare of expiring "bivouac fires, an Officer starting with a few mounted followers. He "is a Staff Officer going to search for a defile through the mountains, "to sound the fords of a river, or to explore the depths of the forest; "such an one will go through great danger without *éclat*, and will make "gigantic efforts unseen by any spectator, his success and his brave "deeds will be recorded by no historian.

"Staff Officers receive in gross the orders of their Commander, and "disseminate them to the Army. By their eyes the General sees the "country and recognizes the resources and obstacles of the ground; "by their reports his genius observes, studies, and divines the enemy's "intentions; and when the decisive day arrives, he launches forth with-"out scruple, their young heads imbued with his own will and plans, "into the thickest of the combat, whither the highest interest of the "Army and the State forbid him to penetrate in person. Such in brief "are the functions of Staff Officers in all European Armies."

All this applied to staff duties in the wars of Napoleon, and while no single particular of these functions has been *simplified*, their whole character has been immensely *complicated* by the introduction of railways and electric telegraphs into the theatres of all modern wars.

The report of the Royal Commission on Military Education justly remarks, that the Staff College is not so popular in the Army as it might be, and I have thought that this may be attributed, partly, to a want of familiarity with the constitution of the College, which is prevalent in most regiments, and partly to a restless competitive spirit which, during the last ten years has been instilled into the students, and which some of them have carried on to their staff appointments, or back into their regiments, to excite the criticism of their brother Officers by a, perhaps unconscious, assumption of superior attainments.

Very striking improvements are about to be made in the course of study pursued at the Staff College; and I shall be only too happy if in this lecture I can dissipate a prejudice, or induce any of the members of this Institution to turn their attention to the College, because our grand deficiency arises from backwardness of the best *regimental* Officers to compete for entrance, and I feel sure that many such are to be found among the readers of the "Journal" of the Royal United Service Institution.

I say the best *regimental* Officers, because there is no point upon which I am more fully convinced, than that you can never make an indifferent regimental Officer into even a passably good Staff Officer by any amount, or description, of education which can possibly be devised.

It is very probable that a bad regimental Officer may pass through the meshes of the examination net, and unless the Commandant of the Staff College, or some other authority, can be induced to exercise most firmly the power of weeding out candidates who come up for the entrance examination, the chances will always be in favour of some book-worms, or men who have mistaken their vocation, surviving to bring discredit upon an institution which professes to educate for the staff.

It should be remembered that one black sheep who has passed through such a school brings more reproach upon the tests which failed to check his career than can be wiped out by ten angels of light who may have been his comrades at the College.

It must be noted, also, that we have had no great war to bring out the resources of Staff College men, and that it is rather hard to judge by their performances as Brigade Majors in peace, because the special duties of such appointments can, most unquestionably, be learnt with greater facility by an Adjutant, at his regimental parade and orderly room, than by any number of years' study at a Staff College.

We will now begin with a short sketch of the history of staff education in this country from the first establishment of the Senior Department at High Wycombe in 1799, up to the present date; we will glance at the course of study now pursued at the Staff College, and the life of the students, giving suggestions as to the

best means of preparation for the entrance examination; and conclude with some general remarks on the character and qualifications of a good Staff Officer, and with a proposition for extending and completing the education, which I can regard as commenced *only* by the College course.

The lack of educated Staff Officers was felt by the authorities engaged in fitting out the expedition for Holland during the last year of the eighteenth century, and General Le Marchant, with the assistance of General Jarry, a French Officer, who had served with Frederick II., availed himself of this opportunity to establish a staff school just before the Duke of York sailed to take command of that disastrous expedition.

I cannot do better than quote the evidence of the renowned Sir Howard Douglas, who thus describes the foundation of the Senior Department:—

"General Jarry, who was the first Commandant of the Senior "Department, was a Frenchman, highly educated in France, who "entered the service of Prussia a short time before the commencement "of the seven years' war, and was on the personal Staff of Frede- "rick II. through the whole of that war. He returned to France, and "became afterwards one of the Generals of the French Army; and in "the year 1795 defected from the French Army and came to London, "where he soon became very generally known as a man of eminent "talent, perfectly master of the science and practice of his profession; "and from his having served so long upon the staff and about the "person of Frederick II., full of the most interesting anecdotes and "instructive details connected with that war.

"General Le Marchant having formed an acquaintance with "General Jarry in London; it occurred to him that if General Jarry "could be engaged to give lectures to a certain number of young "Officers who might be disposed to go and reside where the General "might attend, it would be very advantageous to the service.

"General Jarry was so engaged. A house was taken at High "Wycombe, a considerable number of the rising young Officers of "the day became his students: Sir George Murray, Sir Henry Bun- "bury, Sir Richard Bourke, General Richardson, and a great many "others.

"General Jarry soon found that the rudiments of military science "in the British Army were not sufficiently known to enable the "students to profit by his instruction, and recommended that mathe- "matical, fortification, and other classes, should be established; and "accordingly, Mr. Dalby, a mathematical professor, M. Denis, a pro- "fessor of fortification, and M. Polchet, of the Polytechnic School, "were engaged, and in this way the Senior Department was esta- "blished."

The distinguished General (Sir Howard Douglas), whose words I have just quoted, was himself appointed in 1804 to assist General Jarry as Superintendent of the Senior Department, which then contained thirty students.

The records kept at Sandhurst show that, from the year 1799 up to the end of the continental war in 1815, no less than 290 Officers

availed themselves of the opportunity thus afforded them of learning "the scientific parts of their profession, with a view to the better dis- "charge of their duty when acting in command of regiments, the "situation (says the Royal Warrant of 1808) in which they can best "recommend themselves to Us, and be entitled to hope for advance- "ment in the higher stations of Our service, and at the same time "of qualifying themselves for employment in the Quartermaster- "General's, and Adjutant-General's Departments."

Out of these 290 Officers, 172 are known to have served on the Staff in the Peninsula, America, or at Waterloo, and the following are a few of the most distinguished names among their number:—

Lieutenant-General D'Urban, afterwards Governor and Commander-in-Chief at the Cape of Good Hope.
Field-Marshal Sir William Gomm, late Commander-in-Chief in India.
Field-Marshal Lord Hardinge, late Commander-in-Chief.
General Sir George Scovell, G.C.B.
General Sir Duncan Macgregor, K.C.B.
General Sir James Hope, G.C.B.
General Sir George Brown.
Generals Sir Charles and Sir William Napier.
General Simpson, Commander-in-Chief in the Crimea.
General the Hon. Sir Edward Cust, K.C.H.

Many of these 290 Officers were obliged to embark with their regiments before they had been many months at the College, and some of these returned once or twice at intervals to resume their studies. When it is added that 81, or 27·9 per cent. of the whole, are recorded as killed or wounded, enough has, I think, been said to prove that the late Senior Department must have had weight in determining our national success in the great war.

Our enemies, at any rate, who had ample opportunities of forming a correct judgment, were so impressed with the sense of the great efficiency of the staff which served under the Duke of Wellington, that the famous M. Dupin was despatched to England as soon as peace was concluded to visit and report upon the Senior Department. He remained some time with the enthusiastic Sir Howard Douglas, who had contributed so much to the early success of that institution, caught his spirit, and returned with M. Denis, who was then entitled to a pension from the English Government, to establish, in 1818, the Staff School, which still flourishes in Paris.

In the year 1820 the peace reductions led to the removal of the Senior Department from Farnham, whither it had migrated from High Wycombe in 1812, to its final resting place at Sandhurst, where the Junior Department had been established for some years.

The number of students was, at the same time, cut down from thirty to fifteen, and the establishment of professors from five to two.

We now come to the dark ages in the history of education for the Staff, because the routine duties of home and colonial staff-employment in profound peace, did not demand more education, or ability, than could be supplied by the appointment of any Officers who happened to possess more interest than their neighbours.

There was, therefore, little encouragement for students to incur the

expense* of residence at Sandhurst, except what they could derive from a consciousness of exertion in the path of improvement in their professional acquirements.

Most fortunately, however, one of the two professors appointed on the reduced establishment in 1820, was a host in himself.

Mr. Narrien, to whom I allude, undertook the instruction of mathematics, fortification, and military science; in fact of all the subjects, except surveying and the French language, which were then considered necessary for a Staff Officer's education.

Mr. Narrien remained Chief Professor until 1857, and numerous Officers, who benefited by his instruction, bear witness to his high qualifications, and to the untiring patience and zeal with which he endeavoured to lead them on in their studies.

The mere mention of a few names, gleaned from the roll of students in order of time from 1815 downwards, will, I think, serve to show that the men who were destined to make their mark upon the Service, and to hand down their names as household words to the English public, still resorted to the Senior Department for professional instruction:—

Lieutenant-General Sir George Wetherall, K.C.B.
" W. F. Forster, K.H., Military Secretary.
" Sir Thomas Reed, K.C.B.
" Sir Richard Airey, G.C.B., Commander-in-Chief, and Governor of Gibraltar.
" J. K. Johnston.
" M. C. Johnstone.
" W. A. M'Cleverty, Commander-in-Chief, Madras.
" The Hon. Sir J. Yorke Scarlett, G.C.B., Commanding the Division at Aldershot.
" Sir D. A. Cameron, K.C.B.
" Sir John Michel, K.C.B.
" W. N. Hutchinson.
" Sir R. Percy Douglas, Baronet, late Commander of the Forces, and Lieutenant-Governor, Cape of Good Hope,

and last, though not least, Sir George Grey, K.C.B., who, after studying, as a Lieutenant of the 83rd Regiment, at the Senior Department, turned to civil life and became celebrated as Governor of New Zealand and of the Cape of Good Hope.

The Crimean War, with its *Times'* correspondent, and numerous motions and questions in Parliament during the session of 1855, brought about quite a "revival movement."

A Commission (consisting of Colonel Yolland, R.E., Lieutenant-Colonel W. J. Smythe, R.A., and the Rev. W. C. Lake, M.A.) was appointed to visit and report upon the military schools of continental nations, as well as those at home; and, among the former, the Staff School which had been formed at Paris, on the model of our Senior Department, served, singularly enough, as the basis for the Commission's main recommendations for the reformation of its prototype at Sandhurst.

* Students of the Senior Department had to pay £30 to the College Funds.

It appears from the Report of these Commissioners, that they found the principle of individual competition greatly relied upon in the French, Austrian, and Sardinian Staff Schools, and that it also existed in a modified degree in the Prussian War Academy at the period of their visit.

They were most strongly impressed with this idea of competition, which was very popular in England, and it became, in fact, the dominant spirit of their Report, as it appears in the following language:—

"The contrast (to our own Senior Department) presented by all "foreign Staff schools is certainly striking. There are differences, in- "deed, between these schools in France and Austria as to the period of "admission and other points. But both are alike in *this*, that they are "so framed as to give every conceivable premium and encouragement "to such military acquirements, as the service of this Staff is thought "to require.

"In both the Officers enter by competition, and after a laborious course "obtain their appointments on the Staff as the reward of their distinc- "tions in the school. It seems needless to urge, that a college of this "kind, opening the door to advancement, and frequented when the mind "is in full vigour, would possess every inducement to call forth the "energies of young Officers of talent. But a Senior Department offer- "ing a bare opportunity for military study with no ulterior results, "stands in a wholly different position."

This ruling idea of competition was strikingly confirmed by a resolution passed in the House of Commons on the 28th July, 1857, on the motion of Sir De Lacy Evans:—

"That in the opinion of this House, a higher standard of profes- "sional instruction and more complete provision for it, than hitherto "deemed requisite, ought to be established for the commissioned ranks "of the Army, but especially for the Staff. That this will be best "promoted by recourse to competitive examination of Officers desiring "to qualify themselves for the Staff, and by approved encouragement "for proficiency and general fitness for advancement."

The Purchase Commission also reported in very much the same strain, and the Council of Military Education organized about this time, set to work to carry out what they called the system of pure competition—not only for entrance to the Staff College, but—at all stages of residence therein.

I was myself among the earliest students, and have attentively watched the progress of the competitive system to the present time.

At first, marks were assigned during the two years' residence, *only* to certain surveys, plates, and memoirs, and the great competitive struggle was left for the final examination on quitting the College.

But latterly the system has been complicated by the introduction of many provisoes allowing marks to be made at all sorts of periods in the course, so that it became possible for a student to have collected enough marks to secure success before entering at all upon the final examination. Thus knowing that their names would be published in order of merit, determined by the aggregate number of marks to be amassed during their residence, the students were continually fretted and ha-

rassed by anxiety, which—varied of course according to natural temperament,—but was, in some cases the cause of illness, and often made life a burden during the whole two years' residence.

The worst effect of the system was, the temptation held out to the newly-joined student to choose his voluntary subjects with reference rather to profit in the currency of marks, than to his natural bias, talents, or deficiencies. The system became so complicated, that one often heard the observation, "Oh! if I had understood the marks better at first, I would have taken up such or such a subject, but I did not find it out in time."

To these regulations for marks, there was added a stipulation that each student must attend two-thirds of the Professor's studies in each voluntary subject during the month, besides all obligatory ones; and therefore, in addition to his account of marks, each student had to keep a score of his attendances, and make up deficiencies by going to Professors, whose instruction he did not require, simply to avoid being found fault with at the end of the month. Latterly, however, this rule was modified, and required two-thirds of the *aggregate* of voluntary studies instead of two-thirds in *each* subject; but it was still felt as very oppressive.

A competitive examination is, perhaps, indispensable as the *entrance* test, but after eleven years of trial, the extension of competition *beyond that point* has been condemned by the Royal Commission, upon an extraordinary weight of evidence given against it with remarkable unanimity, by nearly all the witnesses who have been examined. Indeed, we are now retracing our steps, and shall, I trust, re-establish all that was best in the system of the Senior Department, in its palmiest days.

The Commissioners of 1856, who found that the Senior Department had almost died out under the cold shade of 40 years' peace, seem to have been hasty in rushing to the conclusion that the usefulness of that institution could be revived only by substituting a slavish copy of its Paris offshoot. They appear to have overlooked the fact that the Staff Students at Paris are youths who have not yet joined a regiment, and that the competition in book learning, which may be harmless and useful for comparative schoolboys, may be prejudicial among British Officers brought together, *after from five to twenty years' service* in different regiments.* It is to the reluctance of many of our best regimental Officers to enter for a two years' race on such terms, that I attribute some of the unpopularity of the Staff College.

In confirmation of the present Royal Commission's decision against individual competition, may be cited the following observations of Professor Seeley, upon a similar system carried to extremes at the University of Cambridge:—

"It will be admitted that teaching boys is very different from teach-

* One of the Commissioners, viz., Lieut.-Colonel Smythe, R.A., signed the Report under the following reservation:—"For the history and description of the Foreign Military Schools *only*," so we must regard the Colonel of Engineers and the Clergyman as solely responsible for the conclusions and recommendations of their joint Report, dated 12th January, 1857.

"ing men. We find that the boy requires to be constantly supplied "with motives for working, while the man brings these with him. "And though it may be useful to classify men, yet, as soon as the "classification pretends to be exact, it becomes delusive. Who is the "better for learning, that of two good men, one is slightly better than "the other? To act upon this—to give, for example, an appointment "to the man who was fourth, rather than to the man who was eighth, "is, I am sure, a folly; and to many such follies and injustices does "this system of placing men practically lead.

"Meanwhile, the state of mind which is produced in the student by "perpetual competition is far from wholesome. Instead of enlarging "the range of the student's anticipations, competition narrows them. "It makes him careless of his future life, regardless of his higher inte- "rests, and concentrates all his thoughts on the paltry examination, on "which, perhaps, a fellowship depends. The process of reasoning "which goes on in the student's mind, and which you may hear avowed "in his conversation, is this, 'I know what I should like to be doing; I "know what seems to my mind good; I know what I shall study as "soon as I am at liberty, if my taste for study lives so long. But at "the same time, I know what will procure me marks, and it is my busi- "ness now to narrow my mind, and for three years to consider, not "what is true, but what will be set in the examination.'"

Professor Seeley concludes his attack upon the competitive system with these words:—

"I would deliver education from its dependence, and, without re- "nouncing the undeniable advantages of strict and well-conducted "examinations, I would use them, as little as possible, as a motive or "incentive to study. I would appeal directly to the student's love of "knowledge. I would endeavour in all ways to kindle it, but espe- "cially by improving the quality of the teaching, and even if the "result were some diminution of industry, I should find full consola- "tion in the improvement of tone."

I must just add a few lines from a recent account of the Prussian Staff School, to show that the absence of competition is not *there* considered to have proved unfavourable to industry. The present Director of the War Academy at Berlin, which answers to our Staff College, has thus expressed himself:—"Whatever advantages a "system of competition might be supposed to possess in the case of "*junior* schools, it would be entirely unsuited to such an establishment "as the War Academy. The absence of competition is certainly not "considered to be unfavourable to industry; there is no complaint of "idleness."

The General Order issued from the Horse Guards on the 14th instant, has definitely endorsed the decision of the Royal Commission, by ruling that the successful candidates at the final examination shall be arranged in order of *seniority of their regiments*, in two classes, namely,—

1st class "honours,"
2nd class "pass,"

instead of as hitherto in so-called order of individual merit. And I have every reason to hope that these classes will be formed in each of

the obligatory subjects rather than by the aggregate of marks gained in those subjects all added together.

The students will henceforth have much greater freedom of study under the condition of satisfying the Commandant that they are making due progress in the obligatory subjects, and otherwise taking advantage of the means of education provided by the State. We have hitherto failed, I think, to bring forward this obligation in a sufficiently strong light, but I trust that future Commandants, freed from the trammels of the mark system, and responsible solely to the Director-General of Military Education, will feel it a burden upon their consciences to supervise the distribution of this State-paid education with as much regard to probability of return to the State for seed thrown into good ground, as if they were cultivating a farm. In such a case they would not allow seed to be wasted on untilled land, and it would seem equally culpable to permit a student to remain at the Staff College without reasonable anticipation that he would become a better Officer for every month of his residence therein.

It must be remembered that, after all is said and done about the system of a Staff College, its success must depend *mainly* upon the earnest and enthusiastic character of the Commandant, who ought to diffuse life and energy through the ranks of professors and students.

The selection of a military Arnold for this post is indeed a matter of great difficulty for the authorities, and we, who are interested in the fate of the Staff College and its future influence on the Army, may well look forward with great anxiety to the result of their decision.

The introduction of a regulation reserving the Staff appointments of the Army, with some exceptions, for men who have passed the Staff College, has, I think, had an unfortunate effect in raising a sort of half-recognised claim, which has made students feel dissatisfied at not receiving appointments immediately after passing their final examination. Every effort has been made by the authorities to satisfy these supposed claims, but the number of appointments is of course limited, and I am sorry to say that some students have quitted the service in despair of obtaining the reward to which they had looked forward. Just as the training of a steady charger for racing will often unfit him for future service in the ranks, so two years' competition at the Staff College has indisposed even good regimental Officers for the monotony of barrack life.

Having thus reviewed at great length the short reign of the competitive system, and the concomitant evils which have led to its abolition for the future, let us resume the history of the Senior Department, or Staff College, as it began to be called in the year 1858. The other changes introduced by the "revival movement" of that year have, with only slight modification, stood the test of time; and, excepting the higher course of mathematics, the Royal Commission have retained most of the course of study prescribed at the date of their Report.

Professors of military topography, fortification, military history, military administration, and of the French, German, and Hindustani languages, were engaged in 1858, and a Commandant and Adjutant appointed.

A large and convenient building was erected on a good site, in the Royal Military College estate, and opened in the summer of 1862; but the discipline and educational arrangements were still suffered to remain under the superintendence of the Governor of the Royal Military College.

All correspondence of the Horse Guards and Council of Military Education had thus to pass through another channel on its way to and from the Commandant of the Staff College, who is not yet allowed to give even two days' leave to a student without the approval of the Governor of the Royal Military College.

The Report of the Royal Commission has recommended the entire separation of the two Colleges, and has compressed the functions of the late Council of Military Education into one head, styled the Director General of that Department.

Major-General William Napier, formerly Vice-President of the Council, has been appointed to that high office; but no steps have yet been taken to carry out the separation of the Colleges, and so to shorten the chain of responsibility, as recommended by the Report.

Without noticing minor changes which have been imported into the course of study during the last ten years, we will proceed to describe in general terms what is the system at present in force.

Course of Study for two Years.

1st. *Out of doors.*—Surveying during the best weather of the first year; eye sketching without instruments; road making, and schemes for defence and attack of houses, villages, &c., during the third term; practical instruction in bridging, mining, siege works, &c.; reconnaissance in the last term of residence.

Riding has hitherto been taught by two lessons a week only throughout the course; but it is to be hoped that, at the recommendation of the Royal Commission, more frequent attendance may be given at the riding school, and thus future students may be enabled to dispose of this branch of education during their first or second term.

2nd. *In doors.*—Military history; strategy and tactics; military administration and law; fortification and artillery, by lectures, and writing memoirs on these several subjects. Copying examples of ground-drawing plans, sections, &c., of fortifications and siege works; geology, chemistry, photography, and telegraphy, by lectures, illustrated by experiments and specimens.

Reconnaissance is perhaps the most important in its bearing on staff service in the field of all the subjects taught at the Staff College, and it is undoubtedly considered the most interesting by the students.

A sum of £100 is allowed for travelling expenses during the month of Septemper in each year, to enable the Senior Division of students to undertake one or more extensive reconnaissances at a distance from the College. This allowance is always made to go as far as possible, and I should be glad to hear of its being doubled in amount, for its present limit often interferes with the Commandant's freedom in laying his plans of campaign for the students on their annual expedition.

The usual reconnaissance course is arranged as follows:—

The Commandant, taking as his text a tract on "Military Reconnaissance," by General Napier, gives a lecture to the Officers of the senior division, explains the objects of reconnaissance, and the means of collecting the most useful information, and tells them what to observe, and how to record all that is of importance in a military sense, regarding the country to be reconnoitred.

The students are provided with blank forms of road-reports, and are instructed how to fill in their several columns systematically, and to give their report in the most concise terms.

Orders are then issued upon supposed data as to base, lines of operations, objective, position of the enemy, forces on both sides, &c., and the work of reconnaissance is told off in distinct sections to the senior division, assorted into parties of from three to five Officers.

Each party has to make a joint sketch and full report upon the section of the reconnaissance which has fallen to its lot, and the whole work is delivered to the Commandant by a stated time.

After examining the work thus sent in, the Commandant delivers another lecture, pointing out errors and omissions, and giving his comments on the reconnaissance generally.

The hours of study throughout the course are from 9½ A.M. to 4½ P.M., with an interval of half-an-hour for lunch; but it is by no means necessary that students should be employed in halls of study during all the hours thus disposed of in the time table, which is prepared with a view to giving all reasonable facilities of access to professors by ensuring their presence at the times indicated.

The Officers' quarters are comfortable and the mess is conducted on the principles of a regimental one, so that the expense of living is much the same as with infantry regiments on home service.

There is no lack of amusements and society for all who like it. Cricket, racquets, and boating, and the Cadets' gymnasium may be resorted to by those who are disposed for exercise to any amount desired.

Mr. Garth's pack of foxhounds is within easy reach on three days a week, and latterly a pack of drag hounds has been kept by the students, who often find that the *certainty* of a gallop with the latter in the afternoon, and near home, is preferable to giving up the whole day to hunting with foxhounds.

Few, except Mr. Freeman, will deny that hunting is one of the most useful exercises for a Staff Officer, as it gives a tone to his physique and cultivates an eye for country, and horsemanship, all of which are likely to be most useful in his future career.

Forage for one horse is allowed to any student who will mount himself, and it seems most desirable to encourage keeping horses as much as possible.

Life at the Staff College is certainly most agreeable to any one who can make up his mind to give a very reasonable amount of application to study, and I can safely say that I have known few who do not look back with pleasure upon the two years they have passed as students.

Those few exceptions have been men of an anxious competitive

frame of mind, whose sole absorbing interest was centred in marks; —they lived in constant anxiety lest they should be passed in the race by some other student, who had been placed below them in the entrance competition,—or they were devoured by the ambition of passing out in a higher place than the one they had taken at first.

My object in this lecture has been solely to place before the readers of the Journal of this Institution, a general view of the subject of Staff Education, for I have thought that some, who might not think it worth their while to study the General Orders, might cast an eye over these pages, and be thereby incited to enquire further into the system of the Staff College. If any young officer of promise should be so incited, and find the way to distinguish himself and the Staff College in future years, I shall deem myself most fortunate in having attracted his attention to the subject.

It is generally supposed that in order to have a good chance of success at the entrance examination, it is necessary to resort to the assistance of a "crammer;" but I really believe that many who thus fancy that they have found a royal road to learning, are, on the contrary, expending time and money to little real advantage.

The General Order (No. 41 of this year's series specially issued from the Horse Guards on the 14th instant) gives full details, and the reports of previous examinations for entrance published by Taylor and Francis, Red Lion Court, Fleet Street, afford candidates ample opportunities of becoming acquainted with the kind of questions to be expected from the several examiners.

The Military History should be got up by an attentive study of Colonel Hamley's "Operations of War," Colonel Macdougall's "Modern Warfare," "Straith's Strategy," and Lavallée's "Military "Topography," with any works the candidate can collect upon the special campaigns selected for each year's examination and published in General Orders.

In Fortification, perhaps the most useful work a candidate could study, is one on "Field and Permanent Fortification," by Captain Philips, R.E., published by Benjamin Pardon, Paternoster Row.

For Military Drawing it may be desirable to seek a few hints from any friend who has learnt that art, and in future the Garrison Instructors, who are about to be appointed at all large stations, will supply any assistance a candidate can require. I have gone into these details because I have been occasionally asked for information as to the best books which a candidate can read with a view to the entrance examination, and I am most anxious to put on record my firm belief that any Officer of average abilities *can prepare himself* for the entrance examination with very slight exertion, and without quitting his regiment.

It is evident that the success and popularity of the Staff College must depend very much on the character of men admitted, for no education can possibly change the idiosyncracies of men of mature age; and the attention of the Royal Commission was early directed to the failure of free competition to select the best men, as it was expected to have done by the enthusiasts of 1857. I say free competition,

because it is well known that the printed certificate formerly required was signed as a matter of form by most candidates' Commanding Officers, and that it afforded no guarantee whatever of their fitness for the Staff.

The revised General Order just issued, provides a triple check, by requiring a certificate from the Commanding Officer that the candidate is in every respect a thoroughly good regimental Officer; a confidential report from a board of the three Senior Officers of the candidate's regiment in answer to specific questions regarding his character, habits, disposition, and general qualifications for employment on the Staff; and, when practicable, a confidential report from a General Officer to whose brigade or division the candidate should have been attached as an Acting Staff Officer for a month previous to the examination. This change may, I hope be found useful, but I confess that I look for the real security against inefficient students, rather to the power of removal from the College at any period of the course freely conceded to the Commandant. That officer should have the highest interest in the credit of the Institution, and as, during the two years' course, he will have excellent opportunities of observing the characters of the students, he should be held responsible that no inefficient Officer be allowed to reach the final examination.

There is one other point, or rather there are two changes pointing in the same direction, which may I hope extinguish the class of Staff College Officers whom his Royal Highness the Field-Marshal Commanding-in-Chief very justly styled "grumblers" in his evidence before the Royal Commission.

These changes are, the increase of the number of students from 30 to 40; and the suppression of the regulation above referred to, which seemed to create a *claim* to Staff appointments.

The first of these changes must operate in forcing the conviction upon the minds of students, that a minority *only* can ever receive Staff appointments in Peace; and the other will cut away the ground upon which they were wont to build *what* they called *claims*.

These "grumblers" who come to the Staff College for the loaves and fishes of Peace appointments, are not the men to make the Staff College popular in the service, and we want more of that spirit referred to in the warrant of 1808, which has a view "to the better discharge of "duty when acting in command of regiments, the situation in which "officers can best recommend themselves to Us," &c.

The well-intentioned action of the Reformers in 1858 was the result, no doubt, of a belief that the Officers of our Army required a powerful motive to educate themselves for the Staff, and they sought to supply this by throwing open the prizes of five years' Staff appointments to the best in book-learning, because it was easier to establish a test for *that* than for any other branch of Staff education. But in these days the offer of a free education is by no means despised; and now that the bugbear of competition, and the exaggerated stories of hard reading gone through at the Staff College, have been dissipated, I believe that no such motive is wanted.

It should be recollected that, in all other professions, men pay for

their learning, and, consequently, a perfectly free education, with full pay and no duty, is no *small* boon to any Officer ambitious of future success in his profession; he may have to wait, it is true, many years for the war which can alone afford opportunity for making use of his knowledge, but does not the surgeon wait weary years for his patients, and the lawyer for his briefs? yet the State provides neither education nor maintenance for these gentlemen.

Common sense, zeal tempered with discretion, tact, gentlemanly bearing, good temper, quickness of perception, power of condensing and expressing orders with brevity, clearness, and decision, an eye for ground, and ability to ride well, both in the school and across country;—all these, joined to a robust constitution, are indispensable characteristics of a good Staff Officer, but three only, out of the ten above enumerated, can be much improved at the Staff College, and two of those three, viz., riding, and compiling orders, have hitherto failed to receive the attention they deserve. The education obtained at the Staff College is specially calculated to fit an Officer who naturally possesses the ten qualifications, to make use of them to the utmost in *war*, and it seems hardly fair to put such an institution on its trial in time of *peace*, even if its machinery had been set to work exclusively upon raw material possessing the above natural qualities in the highest degree. The actual conditions of trial during the last twelve years have been still more unfavourable to the College, for it has been supplied with raw material, selected without regard to its possession, or not, of any one of the ten requisites, and the machinery has been checked by friction from the competitive system, and other minor evils, which are now abolished.

We are, I trust, entering upon a new era of prosperity for the Staff College, which has borne the searching investigation of a Royal Commission so satisfactorily, that it has been found expedient to increase the number of students to 40; while the changes just being introduced will, I am convinced, make the place more popular so soon as they are widely known.

I look forward to a future war as our only real test of the advantage of a scientific education for the Staff, and when that trial arrives, the Staff College of the period will, no doubt, work its way to the front as conspicuously as did the late Senior Department in the Peninsular war.

War is the soldier's real work, and it should never be forgotten that all peace service is but a preparation for the former. With this view, therefore, in conclusion, I beg, with all due deference, to offer for the consideration of the authorities, a suggestion that the tenure of appointments generally, or at least of the *junior ones, at camps of instruction*, should be reduced to one or at most two years.*

A move of this kind would give rise to a circulation between Staff

* I hope it may be distinctly understood, that I would make no objection to the occasional re-appointment of men who had proved themselves really efficient Staff Officers during their one or two years' trial. What I wish to see abolished is, the sort of "tenant right," introduced by the five years' rule, which practically gives fixity of tenure for that period to any one appointed to the Staff, however unfitted he may prove himself to be for such employment.

and Regimental Service, which would be eventually of great use in completing the education acquired at the Staff College, in breaking down prejudices of both Staff and Regimental Officers, and generally by infusing a more healthy tone throughout the Army.

The Military Secretary, in his evidence before the Royal Commission, very justly observed, with regard to anything like permanence in Staff appointmeuts:—

"If a young Officer gets a Staff appointment of that sort which would "be permanent, the first thing which he does is to marry, which is the "very worst thing which can happen to a young Officer. He naturally "begins to think of his family, and how to provide for them."

This is, indeed, too often the case with the five years' Staff appointments, and even with the two years' settled residence as student at the Staff College; and, while there is so much that can be learnt in one year's practice, as a Staff Officer at one of our large camps, which can never be taught at a Staff College, it seems a great pity not to establish such a circulation as I have suggested, which would remove much of the temptation to matrimony, and complete the education of a larger body of Officers than can, under present circumstances, hope for employment in time of peace.

Some additional trouble would, no doubt, accrue to the Generals and authorities concerned in appointments to the Staff, but this would be compensated by the future advantage of being able to lay their hands upon tried men in every regiment when the services of such are required on an emergency.

The only valid objection that occurs to me, lies in the outlay for Staff uniform and horses; but in these days of economy I do not see why so much gold lace should necessarily adhere to the Staff tunic, and horses might be supplied as they are at present to Officers of field batteries, without much additional expense to the public.

I fear that my proposal will not meet with much favour from those Officers who look upon Staff appointments as the prizes of the Service, to be sought and retained for the individual advantage of fortunate competitors. But I look upon the matter solely with a view to the general good of the Army; and believing that an ounce of practice is worth a pound of theoretical instruction, I should like to see the former distributed among as many Officers as possible during peace, in order that in war, we may have a large reserve of trained men to supply the sudden demand which must arise from an augmentation of the Regular Forces, the embodiment of the Militia, and organization of the Volunteers.

Evening Meeting.

Monday, May 2nd, 1870.

MAJOR-GENERAL WILLIAM C. E. NAPIER, Director-General of Military Education, in the Chair.

NAMES of MEMBERS who joined the Institution between the 4th April and 2nd May, 1870.

LIFE.

Wilson, R. B. W., Lieut. late 15th Hussars. 9*l.*
Newsome, W., Captain R.E. 9*l.*
Digby, Hon. E. H. T., Capt. Cold. Gds. 9*l.*

ANNUAL.

Harris, Charles R., Lieut. R.N. 1*l.*
Fleming, J. W., F.R.C.S., Surgeon-Major late 4th Drag. Gds. 1*l.*
Howorth, R. F. A., Capt. 22nd Regt. 1*l.*
Horne, Charles J., Capt. 16th Regt. 1*l.*
Meade, H. R., Capt. R.E., Madras. 1*l.*
Chrystie, W., Major R.E. 1*l.*
Hare, M. A. S., Commr. R.N. 1*l.*
Percy, George A., Lieut. Gren. Gds. 1*l.*
Leeke, Ralph, Lieut. Gren. Gds. 1*l.*
Cadogan, Hon. C. G. H., Lieut. Gren. Gds. 1*l.*
Gardner, C. H., Lieut. 12th Regt. 1*l.*
Humphry, E. W. Capt. h.-p. R.E. 1*l.*

ON THE MILITARY AND NAVAL FORCE DERIVABLE FROM THE INTRODUCTION OF MILITARY DRILL, AND GYMNASTIC EXERCISES, AS PART OF A NATIONAL SYSTEM OF EDUCATION INTO ALL ELEMENTARY SCHOOLS.

By EDWIN CHADWICK, Esq., C.B.

THE question I have the honour to submit, of the extent of the economy of Military force derivable from the transference of as much as may be possible of Military drill, training, and Naval exercises, from the adult stages of life to the school stages of life, as part of a national system of education, has its basis in a principle of civil economy; in the creation and conservancy of civil force for production.

I beg leave, in the first instance, to place before you the grounds for the economical position as to civil work.

In the Commission of Inquiry into the Labour of Young Persons in Factories, my colleagues of the Central Board agreed with me that the children there employed were so far overworked as to cripple them

bodily, and injure them as workers in after-life. The excessive daily over-bodily work of the children, by excluding them from the advantages of education, also crippled them mentally for after life. My colleagues agreed with me in proposing, as a condition of their employment, that they should be three hours a day in a proper school. I had seen good reason to believe that, well applied, three hours of mental training exhausts their capacity of profitable attention, and is sufficient for children. Having charge of the Bill, I lowered their daily task of bodily work from twelve hours to six. The three hours daily schooling served to protect them from under-mental work, as well as from over-bodily work—all work for the same time, or the same stages as adults being for children overwork. I got this same half school time principle applied in Poor Law administration to the education of pauper children;—but the provisions for the industrial training of the bodies of orphan and destitute children were, in those institutions, inadequate, and to make up for that defect in one of the first establishments for the separate treatment of boys—and also to provide them a destination—a ship's mast was rigged up in the yard; and a man was obtained from the "Excellent," who trained the boys in the Naval exercises, as well as in the Military drill. The results of this combined physical and mental training, which has been followed in a number of district schools where the children have been educated and trained separately from adult paupers, have been invariably most satisfactory. In the parochial and union schools for the same classes of children, without that separate training, two out of three of them went to the bad. The runaway parish apprentices found in the Bridewells declared that they ran away because labour was painful to them, as it doubtless was, from their want of physical training. But with the lads physically trained in the good half time schools, the moral failures—*i.e.*, the failures to get into respectable service, and to keep it,—have been within three per cent. One common entry I met with in the prison entries of juvenile delinquents was, "Father a soldier; mother dead:" or, "Father a soldier; he and mother both dead." Now, of the children of camp followers, as well as orphan and destitute children, and the gutter children in the streets, there was but a common fate, the streets, as mendicants or delinquents, their homes the union house and the gaol. The Royal Military Asylum at Chelsea, and the Royal Hibernian Asylum, are both schools on the half time principle, or very nearly so,—and the children in both receive physical as well as mental training; the first was systematised by the present head master, Mr. McLeod, who had been trained in our first half time district school at Norwood, and both schools are, I submit, eminent examples of what may be done by teaching and training power. I have paid much attention to schools of this character, where accounts are kept of the scholars as to what becomes of them in after life, and where the extent of failure may be most accurately ascertained.

Let me solicit attention to the example of the results obtained by this mixed system of physical and mental training at the Royal Hibernian Military School.

ABSTRACT of the number of Boys formerly in the Royal Hibernian Military School serving in the Army on 1st January, 1869 (date of last Returns received from Regiments).

Rank.	Number in each Rank.	Character.	Number.
Officers	8		
Army Schoolmasters	21	Exemplary	15
Sergeant Major	1		
Band Masters	6	Very good	296
Quartermaster Sergeants	5		
Troop Sergeant Major	1	Good	565
Colour Sergeants	19		
Instructor of Musketry	1	Indifferent	39
Instructor in Gymnastics	1		
Trumpet and Drum Majors	10	Bad	18
Sergeants	59		
Lance Sergeants	7	Very bad	3
Corporals	59		
Bombardiers	11		
Lance Corporals	33		
Musicians	276		
Trumpeters, Drummers, and Buglers	270		
Gunners, Sappers, and Privates	148		
Total	936	Total ..	936

Serving in the higher grades	242	
Serving as Musicians	276	
Trumpeters, Drummers, and Buglers	270	
Gunners, Sappers, and Privates	148	
Total	936	serving 1st January, 1869.
Joined Army since 1st January	47	
Total now serving	983	

R.H.M.S., 14th July, 1869.

I might cite similar returns from the enquiries made as to the outcome of the same modes of training at the Royal Military Asylum, Chelsea, where the proportion of Commissioned Officers to Non-commissioned Officers is similar, with not more than three per cent. of positive failures, the causes of which might well be the subject of a special inquiry. This I apprehend will show the defect to be chiefly the want of previous good infant-school training, at the period when the character is more plastic than is generally imagined. The examination of the outcome of the Royal Naval School at Greenwich was fraught with facts of peculiar educational interest. At one time the education was of a very inferior character, given by inferior teaching power. The punishments inflicted were numerous and excessive; the desertions frequent; the general "ship characters" of the Greenwich boys were bad; they were unsteady, intractable, troublesome, and

frequently ran away. The education and the quality of the teaching power was improved, and its amount augmented, and boys were produced of a general good character. I have not seen the recent returns. Those I obtained were for 1862, when the "ship characters" were, of 150 boys:—"Very good," of 88; "good," of 40; of "fair, promising," 9; "indifferent, lazy, troublesome," 2.

It is fair to observe, that all who come from our superior institutions, the seats of classical teaching, are not angels. Persons are apt to generalise from the residuum to the bulk—from the small, but conspicuous per centage of the "indifferent," or "the bad," against the greatly preponderant number of the quietly exemplary and the very good. But, I beg the special consideration of the example of the results of the teaching and training power of the two elementary military schools. Here we have separate examples of masses of children of the classes, who, if untaught and untrained, are the exposed sacrifices, to mendicancy, vice, and crime, waste, and spoil—these children of common camp followers, advanced not merely to a respectable level of rank and file, but with varied qualifications of rank, almost regiments, complete with superior as well as inferior Officers. Besides a number of staff sergeants, the primary school at Chelsea has furnished 17 commissioned Officers. The general success of the naval training schools has been so good, that it is now recommended as an economical measure that the Royal Navy should be provided with men exclusively from training schools, instead of from the common supply of the loose hands, the refuse of the mercantile marine of the ports. Of those boys of the district, half-time pauper schools, who are trained in naval exercises, a large proportion do volunteer for the Royal Navy. I got an enquiry made from them why they preferred the Royal Navy to the mercantile marine, and the answer was because the mercantile marine is so dirty and disorderly—a good piece of testimony as to the results of early training in cleanliness and order, and to the improvement of the Royal Marine itself. It is to be noted, moreover, that the attractions of the sea service for trained boys have been found to be so strong as, in some instances, to excite the active jealousy of local administrators of the guardian class,—themselves the employers of labour,—to protect their own narrow labour markets.

It would lead me too far away into a political topic, or I might from such instances show the need of superior intervention for the protection of children and of the progress of education, against the narrow interests and the narrow views of these so-called local self-governors.

The experience of the outcome of the half-time pauper schools, where the military drill and industrial exercises, such as those in the Royal Military Asylums, are in use, is in close analogy with that of the asylums. Care is taken as to the places to which they are sent, and they are regularly visited by the chaplains for one or two years after their leaving the institution. On such returns, it is proved that the proportion of the bad, of badness to disqualify them from future respectable service, is reduced from sixty, the former proportion, to within three per cent. Formerly, children of that class required apprenticeship fees as inducements to take them, but now those fees are withdrawn, and

Mr. Edward Tufnell has shown in a recent report, that notwithstanding the prevalent outcries of an excess of population and of over-burthened labour markets, these children are taken into service, even in the east end of London, as fast as they arrive at an age at which they may be sent out. We hear theoretical objections to improved teaching—to teaching on a large scale, which must be by simultaneous teaching in large classes, by separate skilled class-teachers,—that it must reduce the people to one common level. The reverse is the practical result. As we have seen displayed in the military asylums, the development of aptitudes for gradations of rank, inferior and superior,—sergeants, colour-sergeants, staff-sergeants, sergeant-majors, and commissioned officers,—so it is in civil service. It gives foremen, heads of establishments, and positions of command in civil industrial regiments. It is a phenomenon, too, observed by experienced teachers in these institutions, that of those selected, in the most impartial manner, by the schoolmaster, as his monitors, and by the drill master, as his little lieutenants, from their superior intelligence a large proportion are, though perfect *enfants trouvés*, distinguished by various signs, as the natural children of gentlemen.

We hear talk of the Prussian system, of the American, and of other systems, but we have more safe normal instances for our guidance at home, if we can get our members of Parliament to be at the pains to observe them. And yet it will be found, on close observation, that we have by no means got to the end of educational improvement. By good infant-school teaching, nearly two years of school time is saved. By improved organizations such as those in the two Military and the other half-time schools, the three R's are taught to those who come in by the seventh or eighth year before the termination of the eleventh year, instead of not until the thirteenth or the fourteenth year, as in the majority of the national and other State model schools. Yet if we could get the decimal and metrical system made general, we might save half the time now occupied in teaching arithmetic: and if we could get our spelling reformed by a return even to the spelling of Milton and Spencer, of Tyndal and Sir Thomas Moore, we might save half the time now occupied in learning spelling, and the miseries of that learning. The physical training in these institutions, especially in the infant stage, will be found also susceptible of much improvement, and this improvement involves improvement in moral training.

Instruction by precept, proverbially goes in at one ear, and proverbially goes out in great proportion through the other ear. The schoolmaster under old systems cannot tell how much of it is really assimilated and retained for use. The instruction by the military drill is instruction by act and deed, as well as by precept. The schoolmaster tells his scholars to be obedient; but, I say, "the drill-master not only tells them, but sees that they are obedient."

School teachers have confessed the mighty difference that there is in efficiency between teaching by word and by deed.

Now the moral qualities imparted by act and deed are prompt attention, prompt and exact obedience under command, patience, self-restraint. I have had much evidence from extensive employers of

labour, such as Sir Joseph Whitworth, Sir William Fairbairn, and others, that for ordinary labour, the service of the sailor or the soldier is of an efficiency and a value beyond that of a common undrilled labourer. They move quicker and better: they lift together and pull together, and act with more force than the undrilled. Employers of labourers have testified that the volunteer drill has made men worth two or three shillings a week more of wages.

But over and above the common military drill, the exercises of Mr. McLaren, the Oxford gymnasiarch, make a large addition to bodily and industrial aptitudes. From the testimony I obtained at Aldershot and at Chatham, as well as elsewhere, I conclude that the drill, with the addition of the systematized gymnastics, will give to three men the aptitudes of five for all ordinary service. Those whom I have the honour to address will appreciate the civic economy in saving the rations, the clothes, and the lodging of two out of five, of getting out of the capital thus saved a means of giving better pay, as well as a better yield of profit to the capitalist.

I have no hesitation in saying, as I have indeed elsewhere maintained, that if we were to have no wars, if all Europe, as some contemplate, were to become a great federal state, or if we were to become a nation of quakers, the universal drill in the school stages would be economically worth while for civil service.

This being so, as respects the gains derivable in civic economy, physical and mental training, I have now to ask your special consideration of what may be derivable from it of military force and economy. I have made particular enquiries as to the experience of the efficiency of educated and uneducated, naval and military, as well as civil force in the ranks of life. One object of the enquiry was to ascertain with correctness the value of teaching and training power for national education, of which the evidence appeared to be scanty, and the prevalent notions very loose. Besides having had much civil service with eminent military officers of considerable observation, I had very much to do in poor law administration with the pick of Non-Commissioned Officers of the class of colour sergeants and quartermaster sergeants, for whom I exerted myself to get places as masters of union workhouses, for which places I believed they were the best persons to be got, and in respect to whom I had the further policy in view of a co-operation with the recruiting sergeants in case we had had the mass of able-bodied pauperism to deal with, that was threatened on the change of the poor law system. As heads of union houses these Non-Commissioned Officers had in charge the children of paupers, sent there. Whilst the opinion of Commissioned Officers was then, as indeed I find much of it is now, apathetic or antipathetic, to education in the ranks, the effect of which it was alleged would be to make men only "clever devils," or "lawyers" in the dislogistic military sense; the evidence of these Non-Commissioned Officers was clear, decided, and unanimous, from practical experience, as to the superiority in every point of efficiency and value of the educated over the uneducated soldier. I took notes of their evidence, and I submit the enclosed extracts as exemplifying its general tenor:—

"Mr. John Glover.

"How long were you in the army?—23 years.

"What was your rank?—A colour sergeant.

"Where you always in the same regiment, the 91st or Argylshire "regiment of Foot?—Yes.

"Where you often in action?—Yes, I was in every action in which "the regiment fought that we bear on our colours: Pyrenees, Nive, "Orthes, Toulouse, and I was at Waterloo, and have a Waterloo "medal. We stormed Cambray on the 24th June. I was twice severely "wounded, once with a musket shot, and once with a splinter from a "shell.

"Are the men of the 91st principally Scotch?—We had about 300 "Irish and English, the remainder were Scotch; we were about 1000.

"Could the majority of the Scotch read and write?—Almost the "whole of the Scotch could read and write.

"Of course amongst such a body of men you had opportunities of "observing men of the same country who had education and men who "had not, and of knowing them in barracks and on service more closely "than the superior officers. What difference did you experience "between the private soldiers who were educated and those who were "not?—I always found those men who were educated, the best, ablest, "and the most capable of doing their duty. I found men who were "not educated who were suitable men, clean, and well conducted "soldiers. In consequence of their want of education they did not "get promotion; but in general the best educated were the best "soldiers. I thought so much of education, that when a young "recruit came into a company of which I had the charge, I immediately "ordered him to the school. If he was negligent, or did not attend "the school, I gave him a sort of an extra drill, by way of punishment, "to compel him. I have frequently given young recruits pen, ink, and "paper at my own expense to forward them.

"Of those who could read have you observed any who made more "use of the accomplishments than others, and who were found more "frequently with books in their hands to amuse themselves when off "duty?—Yes, and on duty, too; the men when on guard would read; "we had two regimental libraries, one for the privates, and the other "for the Non-Commissioned Officers. The Commissioned Officers "were very kind to us, and made us presents very frequently. One "man in the guard-room would read a book for the entertainment of "the rest.

"What were the effects of those habits of reading?—That they "kept the men in barracks in respectable company, out of the way of "bad company, and out of drink and mischief.

"Have you observed in action the men who were most accustomed "to read; what was their conduct in action as compared with the men "least educated?—I always found the best educated men the best "soldiers in action; they were the most bidable, they were neither too "forward nor backward, but did the best what they were ordered to "do. The men who were uneducated had sometimes in action a

" stupid sort of hardness, but they were difficult in obeying orders; " they sooner got passionate and out of order.

" Were the other Non-Commissioned Officers as anxious as yourself " with relation to the schooling of the recruits?—Much the same."

William Thompson, Sergeant of the 3rd Fusilier Guards.

" When you were a Sergeant in the Guards were there any of the " privates who were accustomed to read?—Yes, we had a good " number in the company in which I was—Colonel Keat's company; " there might be as many as twelve or fourteen who were accustomed " to read.

" What was the general character of those men who could read as " compared with those who could not—their character as soldiers?— " Those men who you saw reading were men who gave no trouble; " you had never to give those men a second order, they always obeyed " pleasantly.

" How did they do what they had to do as soldiers?—None smarter " or better than they were.

" Were you in any engagements?—Yes, I was at Flushing, at " Bergen-op-Zoom, and at Waterloo.

" Had you any opportunity of observing the educated and uneducated privates there?—Yes, I was in Sir John Byng's—the Grenadier " company at Flushing, and I saw the same sort of men there; we had " some very good men there, men whom you would always see reading " when they had an opportunity; we always considered them the " best men in the company as soldiers.

" What was the conduct of these better men in action?—They were, " in general, the most cool and steady. We had amongst us, as " amongst others, ignorant, untaught men, who were always fighting " and reckless in the barracks. These men, when checked for misconduct, were often heard to say that they hoped soon to have a " killing day, in order that the Non-Commissioned Officers, or those " who reported them, might be put out of the way. This sort of men " always turned out the worst soldiers in action, and tried to get away " if they could.

" Then they would be of opinion that education and previous good " training would be good as a means of getting good soldiers?—Yes, " undoubtedly; there could be no question about it.

" Were not many of the Non-Commissioned Officers of your regiment Scotch?—Yes, the great number; there is also a great number " of the Non-Commissioned Officers in the Coldstream and the Grenadier " Guards who are Scotchmen; there are no less than four Sergeant-Majors out of seven in the three regiments who are Scotchmen. " Both of the Quartermasters of the Fusiliers are Scotch."

Mr. Edward Miller, late Quartermaster-Sergeant of the Royal Horse Artillery.

" What has been your experience of uneducated and educated men " as soldiers?—Upwards of two years I acted as Drill-Sergeant at head-quarters, afterwards as Drill Non-Commissioned Officer in Colonel

" Smith's troop, during which time I had considerable opportunities " of knowing the men, and I found the educated men, those who had " received schooling, the best men. They took up their drill the best, " and were the quickest."

The evidence of Naval Officers of similar position and experience was concurrent, with that of the Military Officers, as to the superiority of the educated over the uneducated sailor, in greater coolness, trustworthiness, needing less service of command, from greater intelligence. Naval Officers, speaking of the old sailing ships, estimated the additional force imparted by education at from one-fourth to one-third, that is to say, they would work a ship with one-fourth to one-third fewer men, if the men were of a picked or of an educated class. I submit the following testimony on the Naval question. I had also superior and very clear and decided testimony from the late Captain Basil Hall, that in the Naval service nothing is so wasteful as ignorance.

Captain Adderley W. Sleigh.

" In what service have you had opportunities of observing the habits " of seamen?—For many years I was Acting Master in the Royal " Navy, and I have commanded in the mercantile marine; I was also " trained a part of my time in that service, and I was several years in " vessels trading to the West Indies, and to North and South America, " and other parts of the globe; I have also commanded in the Portu- " guese and Spanish services ships of war with English officers and " crews.

" Have you observed the difference between educated, that is, " school-educated, seamen, and those who are entirely illiterate?— " Yes; I have paid very great attention to them, to their habits, and " relative worth.

" What are the differences you have observed in their relative value " as seamen between those seamen who have been educated and those " who are uneducated,—that is, those who have been so far educated as " to have so much general intelligence as might be shown by their " taking up a book and reading for amusement or instruction when not " on duty, and those who had no such capacity or disposition?—I have " always found the educated seamen the most capable of performing " their duty, no matter what that duty might be, whether it were a " duty of danger or one of skill, provided their acquired knowledge be " regulated by discipline and directed by corresponding intelligence on " the part of the officer; insomuch that, were I fitting out a vessel " myself, I should always, as I have hitherto done, prefer the educated " men, because I should get the greater amount of work from them, " and get it better done, and because I should have the most confidence " in their fidelity. In short, I would rather work a vessel of 600 tons, " say, with 18 men, provided they were educated, than 25 uneducated; " I am now speaking of the mere amount of work to be got from the " men, without reference to their morality or general good conduct. " But of course the intelligent and moral conduct of the men will be

" found also to have its pecuniary value in respect to the safety of the " vessel: for example, if an illiterate seaman be on the watch, and he " be placed to look out for land, he will have little or no regard " emanating from principle to the consequences of his negligence, and " will, without making an effort of mental rectitude, indulge himself in " sleep; on the contrary, the educated man will be moved by the sense " of character, perhaps a perception of what is dependent on his per- " formance of duty, and will be true to it without the necessity of " watching him. It is not to be said the uneducated man is so far " ignorant as not to see the danger—he does see it—he can hardly " fail to be aware of what must be the consequences to his own person, " but either from insensibility to moral character, or from some obtuse- " ness arising out of ignorance, he does not care for it—he indulges " himself recklessly—with him the mate has to be constantly on the " watch, and to be a driving taskmaster; the educated man does his " duty with less labour of overlooking and driving; an ignorant man, " in doing his work, even if the fate of the ship depends on its correct- " ness, will most frequently do it so as will save himself trouble, it " being sufficient for him if it makes an appearance to the eye whatever " it may be in reality. For instance, in setting up a shroud or stay, " if he be not attentively overlooked, it is very probable that he will " not take proper care and trouble to secure the end of the lanyard, " being desirous of getting over the work; on the security of the stay " or shroud may depend the security of the mast, and on the mast the " safety of the vessel and the lives on board, his own life included. " Hence the necessity of a constant eye over the actions of ignorant " and reckless men, and constant rebukes for negligence. They have " no mental firmness or self-control against indulgences; for instance, " if you send a boat with four men on shore, three uneducated, and " one educated and orderly,—if there is delay, it is odds that the " three ignorant men are found drinking in the first public-house, and " the better educated and trained man in the boat as attentive as he " can be in such company to his duty. These circumstances are of con- " stant and daily occurrence, and a large proportion of the immense " maritime loss which the country annually sustains will be found to " be traceable to the ignorance and incompetency of this much-ne- " glected class of men, as well as attributable to other equally lament- " able evils existing at present in the mal-organization of the mercantile " marine. When a general casualty happens at sea, if the ship is in " danger, the first danger the captain has to arrest is, from the ignorance " of men. His first anxiety will perhaps be to have the spirit casks " stove in to prevent the men getting at them, and if defeated in the " attempt, the ignorant men will be the first to rush to get into the " boats and cut them away, by which their own danger is increased. " You are never free in cases of emergency from the dangers of the " panics of ignorance. Since such men are not to be acted upon by " moral motives, you are compelled to flog and use other means of " personal coercion.

" From your own knowledge of the losses that are incurred by " ignorance, or that you think avoidable by education, would you, if

"you were an owner, make a difference in the insurance between two "ships, if you knew that two captains of the same ability had the one "a well educated and thoroughly intelligent crew and the other a crew "of the illiterate and ignorant description?—I have seen and experi- "enced such difficulties in ships' crews, and from that experience I "would say that, as an owner, I should feel comparatively as much at "ease at sending a ship of the first description away with no insurance "whatever, provided it was a good sea-boat of sound material, as I "should in sending away the ship of the same description with illiterate "men lightly insured. If I insured both I should certainly insure the "last more heavily. Captains and officers both of the Royal Navy "and trading marine who have not had their attention drawn to indi- "vidual differences, are apt to view the whole crew as of one character, "and may conclude that recklessness and ignorance is essential to "seamen, and will not perhaps agree with me in my conclusions. But "I am nevertheless firm in the correctness of my reasonings from a "varied experience of seamen under a multitude of conflicting circum- "stances, and the many exceptions that I have found to the testimony "I offer, confirm the opinions I express on the vital importance of "education to seamen as well as to all other classes. I should how- "ever observe, that a man who has received no education, will often, "by serving with the better class of seamen, imbibe their habits, and "we sometimes meet with self-educated men on board ship who sur- "pass any school-educated men on shore, but the general superiority "of the intelligence that may be imparted to seamen by good educa- "tion is, I submit, shown in the admitted superiority of the crews of "the 'whaling vessels' and the crews of others which are upon "shares; an ignorant man who has not intelligence enough to calcu- "late the advantages arising from sharing in the fortunate results of "their adventure will not join such a ship, and prefers what he calls "'a *sure* shilling.' The crews of whalers or such ships are, generally "speaking, intelligent, intrepid, and calculating men. I have had "under my command petty and warrant officers who had served on "board whaling ships, and whose superiority and value as seamen "was without exception remarkable."

I must assume that our naval and military force must always be, substantially, a volunteer force.

If the national education should continue to be what I call a one-sided one, or an education like the present common elementary education, of long time and chiefly mental, I conceive that the predisposition to recruitment will be considerably diminished, but if the proposed physical training be generally superadded as part of the national elementary education, why then the predisposition to voluntary recruitment will be largely augmented. The district schools, as I have stated, chiefly contain children of the depressed classes, and a large proportion of them are below the proper standards; but being free to volunteer, the great proportion of the able-bodied do volunteer for the service.

We all know how much the ranks of the Army are recruited from causes of domestic misfortune;—as being crossed in love, jilted by women, and the like. But we do not know how many of those who

are subjected to these and other crosses are deterred from volunteering by the dread of undergoing the discipline of the drill sergeant. The early drill would remove deterrents, and confer inducements.

A general and thorough national education will furnish a superior quality of population from which the Army must be drawn.

The general testimony of the drill-masters is, as might be expected, that they can give a better drill in the infantile stage—for they may begin as early as from five to six years of age—than is or than can be given ever after. With light pieces they can give a very complete musketry drill. They can also give a good gun drill. With a ship's mast and a rudder and a compass they can give almost anything except heaving the lead and the sea logs.

It is common for the corporal to ask a school-drilled lad, when he joins the ranks, from what regiment he has come; and when he answers that he has come from none, and only from school, to answer that he lies; that he could only have been taught what he has at the barrack, and that he is a deserter. During the mutiny in India, some school-drilled young men, clerks in one of the factories, fell into rank, when the men of one of the regiments who saw their manœuvres declared they were not clerks, but soldiers, who, for some purpose or other, were put into "plains."

Mr. Edward Tufnell, in his report on the Naval training in the district half-time schools, says:—"Captains of merchant vessels are "continually applying to the Stepney Schools, and say that they prefer "these boys so trained to all others." I have often heard their remarks, and I will mention some anecdotes to show their appreciation of this species of training. A captain came to the Stepney School and said, "I have seen a little boy at sea scarcely higher than a coil of rope, "who has been trained at this school, and he is so active and useful "that I am determined to have a boy like him, if I can obtain one." Another day a shipowner called at the school and said that as his ship was going down the Channel on her last voyage, with one of the boys from the school on board, the pilot said, "It would be well if that "royal were lowered; I wish it was down." Without waiting for orders, and unobserved by the pilot, the boy instantly mounted aloft, and lowered the royal, and at the next glance of the pilot to the mast-head, he perceived that the sail had been lowered down. He exclaimed, "Who's done that job." The owner, who was on board, said, "That was the little fellow whom I put on board two days ago." The pilot's rejoinder was, "Why, where could he have been brought up." That boy had never seen the sea before, or been on board a real ship, but these and similar facts appear to me to prove, that it is possible to turn boys into not inefficient sailors by appropriate arrangements on dry land.

The question, then, which I have to submit here is, "What would be the gain from the transference as much as possible, of Military drill and exercises from the adult, or productive stages, to the infantile, juvenile, non-productive, or the school stages of life?"

We can drill upwards of 130 lads in the school stages well at the cost of keeping and drilling one militiaman comparatively ill. My

recent observations lead me to the conclusion that the most economical course will be to drill the school teachers at the training colleges, for the school teachers are more intelligent than the average of Drill Sergeants and Non-Commissioned Officers, and, as far as I am a judge, I think you would say they drill better; moreover, their drill and exercises are constant in the school, and enter into the very fibre of their teaching.

We have had no sufficiently extensive and clear observations to determine precisely what the Military gain would be for the supplementary adult exercises, and I would invite such observations here.

An officer of General Grant's staff informed me that in a little time the service of the educated corps raised in New York was in marked advance over the service of the uneducated men raised from the backwoods and elsewhere, and as he described it, the action of the educational element was in perfect accordance with the testimony I have cited as to the older experience. The like testimony is given as to the quality of the military service obtained in the last war, from the best educated rank and file of the Prussian Army. An officer who has seen good service, who now commands a county police force, declares that he is confident, that with that force, which is about equal in education to a rank and file of Non-Commissioned Officers, he would "roll over" or walk over any common militia or line regiment in the land.

It is known that a comparatively educated man—a policeman—learns the drill in about one-third the time that an uneducated man from the plough-tail can be forced through it. If a young man be brought into the ranks with a better drill, and a higher order of elementary education and intelligence to begin with, it is to be presumed that he will learn everything more that he has to learn, and acquire soldierly habits with comparative speed. The Prussians require three years of preparatory service for their ranks. But their ranks include men of different races, some rather barbarous, that may fairly need long manipulation. The question may be stated thus:—Assume that hereafter recruits are brought into the ranks with a high order of drill, or preparatory drill, and discipline, and intelligence, what further time might be made to suffice? Whether a year, with annual exercises under colours, like our Militia exercises, or what?

Again, the drill being equal, what is the comparative value in efficiency of educated as compared with uneducated rank and file?

Complete elementary education, even such as it now is, would, I apprehend, bring up the rank and file to the mental conditions of the old Non-Commissioned Officers. It would make the force, as it were, a picked force; and, I would ask, how much less of force could you do with if it were picked?

With two regiments, with the rank and file of the quality of the old Non-Commissioned Officers, would you not do the work of three of the present common raff of the line?

I am misinformed if this will not be nearly so. Being so, may we not say, "Mr. Public, you ought not to have—you will not have—this "advanced quality of service, gratis and if you get by it a third more

" of efficiency, it will be worth your while to give for it—and you " needs must give for it—something more of pay, and it is a question " whether you may not make some savings in your commands." The sappers and miners is a corps with a considerable infusion of education in the ranks, and I have heard Sir John Burgoyne maintain that it is a good bargain for the public at the increased pay.

But we educationists can now promise a national education, which will give for the rank and file an education in advance of the average of the old Non-Commissioned Officers,—an advance even upon the rank and file of sappers. By a division of educational labour; by the application of six-teacher power in the place of one in the single-chambered school, getting through "the three R's," with much drill and elementary drawing, by the eleventh year, as I have stated, we gain three years or more of time in which elementary science may be imparted by the thirteenth or the fourteenth year. By a division of educational labour, and the application of ten or more of teacher power, say that in particular schools of the sort described, as high qualifications are imparted in the secondary stages, as usually possessed by cadets at Sandhurst and at Woolwich, on their entrance; for although these new schools have none of the dead languages, they have more of the living sciences. In four years occupied in the secondary stage in the Greenwich Hospital Naval School, or by the fourteenth year, lads are advanced in the elements of mathematics and navigation, in geography and chart drawing, and in practical science, none of which can be got in the common national or parochial schools within the same periods named.

It is not too much to aver, then, that an improved national education on the standard of existing normal of secondary and primary education, will furnish a rank and file in general aptitudes in advance of the average of the present Non-Commissioned Officers.

The facts established in the separate instances I have cited, of the outcome from the mixed physical and mental training, that it does decidedly answer, remove all ground of doubt or misgiving, that in its extended military application it will not answer. The presumption is that further improvement in the quality of the education will be attended with a yet further reduction of the proportion of the addles and failures, and an augmentation of the quality of the available service.

Now, do not all the new arms of precision and of science demand an increase of mental and scientific aptitude for their efficient application?

I have understood it to be the experience of Officers engaged in giving instruction in musketry drill, that the shooting is very much as the education and intelligence. I conceive that the tendency of the changes of the implements, is to reduce the value of bodily force, and to augment that of mental force. France reckons much on the intelligence of her ranks of active small men, in the "war of serpents" with the new weapons.

The working man has been defined to be, for the purpose of civil labour, an intelligent force; but the progress of machinery has been to make him an intelligent director of force. I apprehend that the pro-

gress of the new arms—by which it is, I believe, very much agreed that charges of cavalry are rendered impracticable—by which new arms it is concluded, in military circles in France at least, *l'arme blanche* is virtually superseded for work, and the use of brute force, or hand to hand conflict, abolished; much of the like result is being produced for military work, and the victory is promised to the successful education which shall impart aptitudes to the use of scientific implements.

"Give me early," says Mr. Tufnell, the Government Inspector of the District Half-time Schools, "the children of hereditary mendicants and "delinquents, and I will undertake positively that those children shall "never follow their parents' career." The examples of these schools, and of the Royal Military and Naval Asylums, appear to me to justify the conclusion that if the like teaching and training power were similarly applied for the benefit of the children of the lowest civil population, you would have almost entirely eradicated from the ranks of the Army those evil conditions which are denoted by some 20,000 of court-martials annually, and some 6,000 of soldiers constantly in the Military prisons, not to speak of a reduction of the numbers of some 20,000 men constantly in the Military hospitals for the diseases of vice and filth; whilst the army of civil delinquents constantly under restraint in the civil prisons, and the greater army of civil delinquents living on spoil, from which that prison army is recruited, would be dissipated and destroyed.

In support of the general Military question of the expediency of the introduction of Military drill as part of a national system of elementary education, I may cite the testimony of my friend Field-Marshal Sir John Burgoyne, and a statement in support of its general policy, by the late General Shaw Kennedy,* by Sir Francis Hood, and other distinguished Officers. I may cite also the testimony of colonial and foreign opinion, and of colonial and foreign action. In 1861 I conceived it to be proper to bring under the notice of educationists who came for information to our International Exhibition the question of the half-time system, and of mixed physical and mental training, and took them to some of the schools in which it is carried on. I also put them in possession of the practical evidence on the subject, which I collected for the Newcastle Commission on Elementary Education. That evidence has since been quoted in Canada as the foundation of action taken there with State aid. That evidence was prominently cited to obtain State aid for the introduction of the system into the public schools of Massachusetts, New York, Maine, and others of the Northern States of America, where there is successful progress. It was also cited in Holland, where the Military drill has been introduced into the State-aided secondary schools, and where it is found to answer so well, that it is proposed to extend it as early as practicable to all the primary schools. In France, there has recently passed, at the instance of the Department of Education, a degree which will bring all the lycées of the empire, comprising 40,000 scholars, under preparatory military training.

So that, unless we get the measure proposed adopted as part of our

* See Appendix.

system of national elementary training, we shall be distanced in the application of principles, very much of our own practical initiation—distanced even by the Dutch!

Allow me, in conclusion, to offer testimony, that the elementary schools to which I have referred as under the administration of the Department of Military Administration, over which you, Sir, preside, though doubtless improvable, are, with those of Governmental initiation, to which I have referred, in advance of any others known under civil local administration, and are, in principle, models for study on the great question of a system of national elementary education. Permit me to express the belief that the religious instruction given in the elementary schools under your administration is the best of any going, and is deserving of special study in the great religious difficulty now agitated on public platforms. I would, at the same time, state my belief, that, with much to amend,—especially in teaching discipline in common with the special military academies throughout Europe, and with much to improve in other respects, the military academies under the administration of your department turn out men much sooner, with higher and more solid qualifications,—as proved by the outcome,—for the civil as well as the military service of the country, than any other institutions for superior instruction that we possess. In your scientific schools, a youth has had a special scientific training, and is in a scientific profession by about the time he is turned out of the Universities, with much that he will find useless, to seek and begin his preparation for one. I think it a matter of congratulation that the example has at length been set by the distinguished Officer at the head of the Royal Military Academy, Woolwich, General Sir Lintorn Simmons—a step which I long ago recommended,—of giving marks for physical attainments in superior education, as they will serve as a motive and a check preventive of the injuries done in ill-regulated competitions by over deskwork, and will in reality conduce to sound and lasting mental attainment. I trust that you will withstand reactionary tendencies, and that under your auspices and those of your colleagues, our military educational institutions may be kept to the fore, and serve as yet further advanced models for civil educational institutions.

APPENDIX.

Extract from a Letter from Lieutenant-General Shaw Kennedy.

"It appears to me that this country is drifting rapidly into a totally "new political position—not new as regards its whole history, but new "as regards its history during modern times, when it maintained an "unquestionable mastery at sea. It would, therefore, in my opinion, "be the most extraordinary blindness and delusion conceivable, should "the people of this country rest upon the opinion that they are to be "secure without making preparations for defending themselves on their

"own shores as well as at sea. This is the view that was taken by "Mr. Pitt and Mr. Fox in 1803, as so well brought forward now by "Mr. Smith in the pamphlet which he has just published. By the "measure then adopted by Parliament, with the entire concurrence of "these two great men, every man in the country between the ages of "fifteen and sixty was obliged to serve under penalty, not of fine only, "but of fine and imprisonment. Every man was enrolled; not only "that, registers were taken of the animals and of the waggons, and a "conductor appointed to each ten waggons; so that even a vast system "of commissariat was actually arranged for immense numbers of men "called upon to serve. Our wisest men, and the whole country, con- "curred in the propriety of these measures, and observe, they were "taken at a time when our fleet was greatly superior to that of "France; and observe also, that our statesmen of that day stated "clearly and explicitly that they approved of these great measures of "land defences, notwithstanding their being perfectly aware of our "great naval superiority. Observe, also, the enormous number of "men thus called out. One in every ten of a population between "fifteen and sixty would be actually efficient if called out. In Great "Britain alone the measure would bring two millions of men actually "under arms, that is, excluding Ireland. These numbers are enor- "mous, as compared with those which I have proposed, yet the numbers "which I have proposed are considered ridiculously great by some "military critics. Now, although I think that what Pitt, Fox, Wind- "ham, and my old general, Robert Crawford, said in Parliament in "1803, on the subject, in a political point of view, was worthy of the "exalted opinion entertained of them as statesmen, I cannot admit "that they entertained military views that are tenable now. It must "be recollected that since their time great advances have been made "in a knowledge of the higher parts of war; and although a very "large body of men is unquestionably necessary for the effectual "defence of the country, I think that the number of men to be actually "under arms that I have proposed, is sufficient.

"The possessions of this country are so extensive, and her com- "mercial relations with the rest of the world so great, that she is con- "stantly coming into contact with all the nations of the globe. She is "constantly, therefore, engaged in war, and will continue to be so; "and in fact this is about the most warlike nation that ever has existed. "But with this, strange to say, and paradoxical as it appears, the "common observation is true—that the population of this country is, "to a most remarkable degree, unmilitary. Now, this is the very fact "that philosophers may fix upon as a state of things desirable to be "continued, and may argue that all attempts to make the people of this "country more military is the reverse of being desirable. This view "appears to me to be a fallacy; and now that naval warfare is changed, "the Channel to a certain extent bridged, and France, America, and "Russia increasing so much in naval power, the fallacy appears of a "most dangerous character. But besides being dangerous, it appears "to me to be an absurd apprehension as regards this country. The "people of this country may—and ought to be—made more military

"than they are at present. But nothing is to be made of this in the "shape of gain; and there is no conceivable reason that I can see why "it should turn them from their industrial pursuits.

"According to the principles which I have stated—should those "principles be correct—there will in future be required to be held con- "stantly in readiness for the protection of this country a very large "number of men who have undergone a certain extent of military "training, and who are organized, in addition to the regular army of "the country. This, in my opinion, will be a sufficient protection to "the country without the employment of a large standing army.

"Having stated these principles, I am now able to give direct "answers to the questions contained in your letter. It is evident that "if a national force is in a great part to be substituted for a standing "army for the defence of the country, that the better that national "force is drilled, disciplined, and made acquainted with the use of fire- "arms, the better; and I say, without hesitation, that I conceive no "other plan would accomplish this so thoroughly as that of military "exercise being made part of the course at school, as proposed by "Mr. Chadwick, if such a system can very generally be introduced. "I have read over with great care the three heads under which "Mr. Chadwick classes the effects of such a system as part of the "education at schools—viz., 1. Physical and Sanitary; 2. Moral; "3. Economical and Productive; and it seems to me that his inferences "under those heads cannot be controverted.

"You say that Mr. Chadwick would also ask my 'experience and "'observation of recruits who had been previously drilled in any "'schools, on which subject Mr. Chadwick has had already the testi- "'mony of some Officers of experience.' I apprehend that the reply "to this, on the ground of experience, can, in this country, be alone "derived from the result of the drill that takes place at our military "colleges; and I conceive that the effects of military drill and exercise "and the use of fire-arms, taught at schools, would to this extent "never be forgotten, that a youth so taught would, at any future "period, with a very slight degree of practice, renew his knowledge of "what he had been taught."

The CHAIRMAN: If any gentleman wishes to make any remarks upon what has fallen from Mr. Chadwick, we shall be happy to hear him.

Sir HARRY VERNEY, M.P.: We must all of us feel very much obliged to Mr. Chadwick for having brought before us a question which I believe to be of great importance. Many of the observations that he has made I confess had not struck me before, but I daresay he is perfectly justified in them. For instance, it had not occurred to me that men who were likely to make good soldiers, are prevented entering the Army by their dislike and objection to the recruit's discipline and drill. I should not be surprised to find that that is true, and that many a fine young fellow who would make a good soldier does not like to go through the required drill. This is a very great argument for giving that kind of physical discipline in our schools. It could not fail to be beneficial in every point of view. And I think the considerations which Mr. Chadwick has brought before us in favour of the half-time, deserve our attention, for there is no doubt that a child may be taught more on that system than when he is drilled by being kept a number of hours in school. The advice he has given with regard to the military training of teachers is also very important indeed. Military training ought to be introduced into our normal schools, because we all

know that if the teacher has learned military discipline himself, he is sure to instil it into his scholars. It is a valuable suggestion, for which we are very much obliged to Mr. Chadwick. With regard to education and mental capacity making men good soldiers, I believe what Mr. Chadwick has told us is perfectly true. We shall all agree that there were never better soldiers in the field than the Prussians showed themselves to be in the campaign of 1866. A near relation of mine, a lady, was spending some months before the war at Görlitz, in Silesia, on the frontier of Saxony. An offer was made by the Government to the master of the house in which she was living to take either five Officers or forty-three privates. The gentleman preferred the forty-three privates. She told me she used to go and talk to these men, and she was surprised to find how very well informed they were. They seemed to understand not only their military occupations and the principles upon which military movements ought to be conducted, but she learned a great deal from them with respect to their different professions and trades. They were agriculturists, artisans, carpenters, and bricklayers, and they all seemed to understand the principles of their work. These were the men who distinguished themselves so much as soldiers in the field in the course of that short campaign. She told me that their conduct was admirable. During the two or three months that she was in the house with them, not the smallest complaint was made of their conduct. They preserved their discipline; they were frequently engaged in some mental recreation; many of them had books; they subscribed to the libraries of Görlitz. Their behaviour and occupations showed the great value of the mental education that they had received. As we all know, when they were brought against the enemy, they proved themselves to be most admirable soldiers. I am very glad to hear Mr. Chadwick's observations on the Stepney schools. I have seen those schools myself, and after a long visit which I paid to them, I made up my mind, whenever the opportunity should arrive, to press upon the House of Commons to get the naval and military drill-system in operation at Stepney, introduced, when practicable, into our schools. I think every school supported by a public grant of any sort or kind ought to have the system of drill introduced. It cannot do the boys any harm, and it may do an infinity of good. When I was a boy I think drilling did me a great deal of good; and if men, when they join their regiments, whether afterwards they are Officers, Non-Commissioned Officers, or privates, have learned their drill, and learned it in early youth, they find it an important advantage. I believe there is no military man who will not say that he found it so when he came to join the Army. Mr. Chairman, we are exceedingly obliged to Mr. Chadwick for bringing before us practical points of great importance, socially and politically, as well as to the Army and Navy. I, for my part, feel very much obliged to him.

Captain DAWSON, R.N.: As Sir Harry Verney has answered for the Army, I rise to say a word for the Navy. I had the honour of being associated with Mr. Edwin Chadwick at the Social Science Congress at Manchester, when he was kind enough to preside over the section which took charge of the social condition of merchant-seamen, where we had a large and respectable audience, consisting of one individual besides the speakers. We have a small audience here to-night, but we have this comfort, that the paper will be published in the *Journal* and will be read by naval and military Officers in all parts of the world. Therefore, the excellent ideas that Mr. Chadwick has brought before us will have the advantage of being promulgated amongst those who would have been here if they could to have heard this paper read. I have myself spent ten of the best years of my life in the training and instruction of men and boys, five years certainly devoted to the training of boys in one of Her Majesty's training ships. That, of course, has given me the opportunity of forming some opinions in the course of the observations which I made. I cannot say that I go quite as far as Mr. Chadwick in his worship of education. I agree with his practice, but I do not agree with the inference that he draws from his practice. I do not think myself that mere mental education makes a man necessarily a more moral man than he was before. I believe the great evil we have to contend with in the Navy, as in the sister service, is immorality and vice. Take away vice and immorality, and you will certainly strengthen the physical powers of the crew. But I do not think you will do that by simply improving their educational powers. The

great end to be accomplished by strengthening the moral powers of men is not to be attained simply by mental education alone. As Mr. Chadwick's observations certainly went a good deal in that direction, I should like to put in my protest very strongly against the impression going forth, that I for one agree with that idea. If we were to go out at this moment into the Haymarket, you know what we should see. Who is it supports those prostitutes? Educated men. Men-of-war's men are physically and mentally the best educated portion of the working classes; yet it is for them the Contagious Diseases Act exists. Therefore it is wrong to say that it is education which brings morality. Morality must stand upon a much higher basis than mere mental education. There are only two things to make men moral, one is the fear of God, which is the beginning of knowledge; and the other is the fear of man, which is commonly called pride. We must look to Christianity and make men Christians, in deed as well as in name, if we would get rid of the immorality and vice which disgrace the two services. But apart from that, I agree cordially with Mr. Chadwick in the belief that physical development is a most important element in the training of youth. In the course of my five or six years' experience in training a large number of boys, I have often observed lads coming on board looking excessively stupid, hardly able to turn their heads on their shoulders without turning their body round, with a bent back, and walking with great strides. See those boys in the course of three or four months, their backs straight, their heads ready to turn round in any direction, their eyes on gimbles, and looking as smart and as sharp and as intelligent as you would wish to see them. Most astonishing it has been to me to watch the progress made in three or four months. What was it that accomplished that result? It was not simply their being put to school. I took great interest in the school personally, and conducted the examinations quarterly, besides looking over the work from day to day; therefore I am not adverse at all to mere mental education. But it was not that which developed their intelligence. It was the going aloft day by day on the rigging, laying out on the topsail and topgallant yards. That was the sort of gymnastic exercise which was daily engaged in, and which forced them to exercise their ideas and which developed their intelligence. So much so, that on one occasion I remember, when an Officer commanding another ship, an Officer of some standing, who took a very great interest in the training of youth, came on board and saw these boys knocking about 8-inch guns, he asked me how we managed to get them to do so well. I said, "they learned that on the topsail yard." He looked at me with astonishment, and could not understand how they had learned their gunnery on the topsail yard; but I explained that it was in the rigging that they sharpened their intelligence and developed their muscles. I believe it is quite possible, by merely putting up a mast and yard in a playground on shore, to teach the youngest boys such muscular exercise, put them through such gymnastic evolutions as would make them most intelligent members of the community. Whether they afterwards became tinkers or tailors, soldiers or sailors, or whatever trade it may be, that training would be of great use to them in making them more intelligent members of the community. Then I believe very strongly in military exercises, as a matter of discipline. It enables you to train and keep in hand a number of boys; it enables you to develope their chests and muscles; and I believe it has great moral power. A little bit of military discipline introduced into any school has a very beneficial effect. I think the half-time system is a very important point, the great point which Mr. Chadwick wants to put before us. I think four or five hours a day at school is quite as much as any boy is capable of, the rest of the time to be given up to physical recreation of some kind: some gymnastic exercise or other which will develope muscles and employ the intelligent faculties. But there is a difficulty in one point. I foresee a great difficulty in getting those boys who have got a taste for sea afloat, into the mercantile marine, from the indisposition on the part of shipowners to take a sufficient number of apprentices; and I believe that difficulty will discover itself more and more as we extend the number of training ships round the coast. There is one little misprint in the paper which should be corrected. It is a point which would strike a nautical ear. Mr. Chadwick spoke of lowering the royals, it should be furling the royals. I would merely add that I cordially agree as to the practical value of nautical training and military drill, in

combination with scholastic studies, for developing the mental and physical powers of youth; although I do not agree as to the moral influence of mere secular education upon any class of society, high or low. Mr. Chadwick favoured me with his ideas on this subject once before, and I came here this evening prepared cordially to agree in the opinions he has expressed, having, as I said, had five or six years' experience in the training of boys.—In reply to a question by Mr. Chadwick, Captain Dawson said, I think there are very few seamen in the Royal Navy entered from the merchant service. The greater number of seamen in the Royal Navy enter as boys, and are trained up by ourselves in Her Majesty's training ships. The entries from the merchant service at present are very small.

Mr. W. Foster White, Treasurer of Christ's Hospital: I know not to whom I am indebted for the invitation to attend here to-night, but whoever may have been kind enough to send me that invitation, I beg to thank him for giving me an intellectual treat. I am very thankful to Mr. Chadwick for having imparted to me an amount of information which I have very earnestly desired to receive. I do not represent either of the services here, but simply a large educational establishment in the City of London, that of Christ's Hospital. It is an institution in the mouths of most people at the present time, and the Governors have for years past been labouring assiduously to see how they could further increase its efficiency. Among other matters, I confess for one I have been most anxious to institute drill. I have heard from the Officer who spoke just now, almost an answer to the question, which I was very anxious to put. He strongly recommends that there should be a less amount of scholastic time occupied, and that more time should be given to drill and gymnastics and such like matters. Now, there is precisely the difficulty which we have to deal with at the present time. There is the difficulty between those who govern and the schoolmaster, who asks that the boys, early and late, throughout the day, should labour and cudgel their brains to the very utmost, in order to take that position in life for which we endeavour to train them. And the great question is this, how are we to introduce drill without intrenching upon their play-time? The boys necessarily must have a certain amount of relaxation, and I should feel very much indebted to any Officer present who will supplement the observation which this gentleman made just now, that he strongly recommends that a certain portion of time in the week, or in the day, should be devoted to gymnastic exercises. In another institution with which I am connected I have seen the beneficial effects of the drill, more particularly when supplemented by music. The children of that institution were formerly turned out into the world as journeymen tailors or journeymen shoemakers, and I am sorry to say that a great many of them gave much trouble. But since the introduction of a juvenile band into that institution, the boys, upon leaving, have been drafted into various regimental bands, and we cannot supply them fast enough. It has been a great success. A juvenile band has been recently formed at Christ's Hospital. It is yet in its infancy; but I think I see sufficiently before me to say that it will be a glorious success. Therefore, if any Officer will be kind enough to give me his opinion upon the matter it will strengthen my hands and the hands of those who are labouring diligently with me, in considering how best to introduce drill, so that as little time shall be taken from school as possible, and yet leave the boys a fair share of time for play; for I confess I consider drill a most desirable thing to be introduced.

The Chairman: There is a gentleman here who I think can give you details upon that point, if he is willing so to do, viz., Mr. McLeod, the Head Master at Chelsea. He is present, and perhaps will be good enough to give us some details on the subject of drill

Mr. McLeod: I was not aware that I should have been called upon to make any remarks with reference to Mr. Chadwick's paper, but I shall be very happy to give any information upon the subject of the educational drill, so far as the Royal Military Asylum is concerned. When these schools were first established, about twenty-three years ago, a considerable portion of the day was devoted to intellectual education. But it was found afterwards that too much time was spent upon mere writing and arithmetic, and the other subjects taught in the schools. Therefore, it was considered advisable to reduce the hours devoted to mental occupation, and

to give the boys more time for play, for recreation, and for physical exercises. The drill and gymnastic exercises are in the hands of the military authorities; neither myself nor any of the other masters have anything whatever to do with the physical education of the children. We have found, however, that by reducing the time that was previously devoted to intellectual education, we have been enabled to produce results at least as good as those that we were able to effect twenty years ago. Where we had at one time five or five and a half hours a day devoted to intellectual education, at the present moment we have, according to Mr. Chadwick's scheme of half time, not more than about twenty or twenty-one hours a week, and we find that the results are quite as good as they were twenty years ago, with twenty-eight or thirty* hours a week instruction. The time taken from school hours has been devoted to play and recreation, and the results are what I have stated. I am not quite certain what it is the gentleman wishes to know with reference to the periods to be devoted to drill, and the periods to be devoted to education. If he will be kind enough to put the question, I will endeavour to answer it.

Mr. FOSTER WHITE: If you will allow me to put myself in communication with you, I shall be very much obliged to you.

Mr. MCLEOD: I shall be very happy so do so; but if you will repeat the question, I might now give you a direct answer.

Mr. FOSTER WHITE: The question I wish to ask is, if by diminishing the hours of education, and devoting a certain portion of time to drill, we might fairly anticipate the same intellectual results from the boys?

Mr. MCLEOD: I have already stated, that, previously, we devoted about thirty hours a week to education; during the last ten or twelve years we have not had more than twenty-one hours a week; yet I believe I can conscientiously say, that the education of the boys, omitting one or two subjects, which are not of any material importance, is quite as good, if not superior to, what it was before.

Mr. CHADWICK: May I ask, rather for the information of members of this Institution than otherwise, in how many years do you get your boys well through the three divisions? I think they come in between seven and eight.

Mr. MCLEOD: That is rather a difficult question to answer. First of all, we do not get the children into our schools at seven years of age; the majority of the boys, I should say, do not enter the establishment until nine years of age; a great number of them do not enter until they are eleven years of age, and some of them enter at twelve years of age, and yet they are supposed to leave us fairly educated at fourteen years of age. But the average time of the children passing through the establishment is about five years. I think I may state with reference to any good school, where you find a thorough school organization, an efficient system, and trained masters, that you will be able to give the reading, writing, and arithmetic necessary for all the common purposes of life, and in addition, music, elementary drawing, elementary drill, and gymnastics; I think you may do all that by eleven years of age. At the present moment, in the civilian schools, you do no such thing. In the majority of the national schools throughout the country, you cannot get such an education, for various reasons; one is, because the schools are generally too small. The labour that is expended upon fifty children might be beneficially exercised upon greater numbers. With larger schools you have more perfect organization; and where you have an efficient organization, and a better classification of pupils, you must have a better system of education—you must have better education altogether. Hence it is, that with the form of organization which exists at the present moment in all large schools, such as the Chelsea school, where there are from four to five hundred children, and arrange those children, not according to their ages, but according to their qualifications, and have well trained masters, then, I say, you can send out children fairly educated by the eleventh year.†

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* The number of hours per week were at first twenty-nine, then twenty-five, and now twenty-one.

† Children who have passed through an infant school, and who had attended regularly a good primary school, should, by the *eleventh year*, in addition to Bible lessons, music, and elementary drawing, be able to read with ease and intelligence, to write

Mr. CHADWICK: That is to say, the education going on up to the eleventh year would, in the national schools, which are thought tolerably good, occupy the boys till they are twelve or fourteen.

Mr. MCLEOD: Quite so.

Mr. CHADWICK: And at less cost, per head, of teaching power.

Mr. MCLEOD: I am not prepared to give an answer to that question. As regards the effect of the drill, that has been stated already by Mr. Chadwick. The drill makes the boys smart, makes them obedient; and you know, where you have ready obedience in a school, there you have more perfect discipline. In all schools where the drill has been introduced, there is an economy of time in going into and coming out of school, in going into and coming out of class. Those who have been drilled, do the various movements more quickly, and they do them simultaneously; hence there is economy in time, and the time which is now lost in those schools where such exercises are not taught, could be devoted to other subjects. There is only one subject in Mr. Chadwick's paper which I should like to make a remark about, that is, the religious difficulty. Mr. Chadwick made a remark with reference to the method in which religious instruction was taught in the regimental schools throughout the country. Every one knows that the religious difficulty is that which has stopped, and which is likely to stop, the passing of that Bill—taking it altogether, a most excellent one—which has been introduced by Mr. Forster. The religious difficulty does not, in my opinion, exist at all in reality; it exists only in imagination. Take nineteen schoolmasters out of twenty, and they will tell you that they have had children of all denominations in their schools, and yet the parents have never, at least as a general rule, made any objection to the manner in which religion was taught those children. The only difficulty in the common schools is with respect to teaching the catechism. Now, we get over that difficulty in all our regimental schools. The first lesson given in the morning, from nine to half-past nine o'clock, is the Bible lesson; here there is what may be designated "the time-table conscience clause." If any parent objects to his children attending at that particular time, the child absents himself; but he attends at half-past nine, the hour for commencing general instruction. If, however, any dogmatic, any specific religious instruction is to be taught, that is given by the ministers of the different religious denominations. A certain hour, or certain periods, are set apart during the week, when such religious instruction is given by the Church of England clergyman, by the Presbyterian minister, and by the Roman Catholic clergy to the children of their own respective persuasions. Now, if the same system, or a modification of it, were introduced into all schools in England, the religious difficulty, in my opinion, would altogether vanish.

Mr. CHADWICK: Would you allow me to ask what is your book of Bible lessons; what book do you use? I have a reason for asking.

Mr. MCLEOD: We give our Bible lessons from the Bible.

Mr. CHADWICK: Don't you use Stow's book?

Mr. MCLEOD: We use Stow's *method* of giving religious instruction; but all the lessons are taken directly from the Bible itself.

Mr. CHADWICK: I have been told Stow's book is the best that can be applied for the purpose; at all events, you have got Presbyterians, you have got Church of England members, and you have got Catholics, and you say you have overcome the difficulty.

Mr. MCLEOD: We have no difficulty at all; in fact, there cannot be any religious difficulty in our regimental schools.

Mr. CHADWICK: In answer to the observation of Captain Dawson, that he cannot go with me to the full extent in what I have stated as to the efficiency of educational power in the production of moral results, I may remark that his observation may relate to old educational systems of exclusively mental and long-time teaching; but mine relate to the new half-time system, of mixed physical and mental training, which is widely different, in which I must take him with me perforce as to

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clearly and legibly, and to work intelligently questions in the simple and compound rules of arithmetic, reduction, fractions, and proportion.

what may be done to the statistical returns, which are absolute, as to the proportions of "the good," "the very good," as compared with the small proportions of the indifferent, the bad, and the very bad. We have no returns of the outcome of the old and most expensive superior education, some of which may perhaps be seen in the places he has named; but we do know, as I have stated, that it does not invariably produce absolute angels. The effect of the improved applications of teaching and training power could only be appreciated by those who have examined the outcome of old conditions, as I have had to do in Poor Law and in penal administration. That experience warrants the positive declaration that, under the conditions of no schooling, or of the very common conditions of inferior schooling, that the proportions of the indifferent, the bad, and the very bad to the good and the very good, would be reversed. With the gutter children they are reversed. I think that the statistical evidence to the points is as decisive as any of which the nature of the case admits. The evidence is not of a single school or of a single educational institution, but it is of the examined outcome of separate institutions, with separate races of children, Irish, chiefly in Dublin, English, and other races in England, all with well observed coincident results. Hence it is, with such clear outcomes for examination at home that I deprecate going abroad for evidence as to training and educational power. Nevertheless, properly examined, there is evidence of recent foreign experience of the value of education for military force in war. I apprehend that no one here would depreciate the fighting qualities displayed in the recent civil war in America. From an Officer on General Grant's staff, I had a good account of the greater efficiency of the educated force, obtained from the New England cities, as compared with the less educated force drawn from the backwoods, or obtained elsewhere. I believe the experience there was in perfect accordance with that of the older practical experience displayed in the discriminating practical testimony I have cited. Distinguished as was the service of the Prussian educated force in battle, it was yet more distinguished after battle. It was magnificent, and unequalled heretofore in Europe, in the self-restraint, in the treatment of the vanquished, in the care of wounded enemies, in the entire moral conduct of the ranks,—in moral force, which is equivalent to military force, conducing to the retention, as well as to the extension, of their conquest, by the removal of animosities amongst peoples. I got this testimony of them from a friend, an Army chaplain, who was close upon the war track. The strongest display of temper on the part of the conquerors was, I am told, upon the Frankforters, who, for insults and provocations, for which the first Napoleon, "pour egayer les soldats," as he expressed it, would have given the city up to be sacked, were subjected to a requisition of twelve cigars daily, and there the the people said the privates behaved like gentlemen—whilst their Officers, in inflicting this requisition, behaved like snobs. In answer to the inquiry made in behalf of that great City school, Christ's Hospital, that they were disposed to move in this direction of giving physical combined with mental training, I am sure that Mr. White, or any other gentleman, if he will visit some of these military schools, he will receive the best information that now can be given, until proper training colleges on right principles, can be obtained, and which must be had before a sound national system of education can be instituted. At present, educational and training power is only in its infancy for general application. The right adjustment between the powers of body and mind, between mental and physical training, has yet to be ascertained and made prevalent. It is only recently that the capacity of the mind, its receptivity, so to speak, has began to be considered. The examination of its powers of retention is a new art, and the extent of those powers have, in some large instances, only been recently ascertained by accident. During some unusually severe hot weather in Germany, the children were prevented going to school for more than a short part of the day; but it was found afterwards, upon examination, that they had acquired in the short time as much as they had been accustomed to in the long school time. Even in a half-time school, the central district school of London, in consequence of building that was going on, or something of that kind, the school time was positively reduced from 18 to about 10 hours a-week, and they found that the children gave almost as good results from the more brisk short-time teaching as they had given in the longer hours of slower teaching. The scholiast, the man of the cloister, has fancied hitherto that

if he had a child before him continually, that child would receive and retain all that was poured forth upon it with a look of attention, during any number of hours that it could be kept in its seat. Examination is a new art, and that new art shows that very little of the long-time teaching is retained. That new art requires greatly to be studied and applied. To conclude, I beg to return thanks for the attention accorded to me by the members of this Institution, particularly to Sir Harry Verney for having come down here; and I shall be still more thankful if, in his place in Parliament, he will insist upon this physical training as part of the national elementary education of the people. I am confident that on a close examination of the normal and of the practical testimony I have cited, that the half-time principle of mixed military, physical, industrial, and mental training, whilst it will give an addition of about one-third to the civil productive force, it will give the like addition to the military force of the empire.

The CHAIRMAN: I am sure we have all listened with great pleasure to the lecture which we have heard from Mr. Chadwick. I need not say (because it is fully recognised by the gentlemen who have been good enough to make observations upon it) that it is a subject which is considered by them to be of very great importance. I confess I am entirely of that opinion. I think it will be a great gain to the country if Mr. Chadwick can succeed in his endeavour to get this system of military drill and naval exercises introduced into all the national schools. I am perfectly certain it would be of immense benefit to the Army, because it follows, as a matter of course, as Mr. Chadwick has observed, that if a man is drilled when he is a boy, drill is no longer new to him; he is not afraid of it, and he does not require to be much drilled when he comes into the Army. I was myself drilled as a boy, and was never much drilled afterwards, I mean not elementarily. And that is the case with many Officers of the present day who have been taught their drill at the Military Colleges before they enter the Army. I do not know that there is any particular point that calls for observation from me. The advantage of the proposed plan appears to be self-evident; it does not require any argument to prove that physical training, combined with moral and intellectual training, is the best education for any boy. Therefore, I won't detain you by any unnecessary observations, but I will ask you to join me in tendering our thanks to Mr. Chadwick for the exceedingly interesting lecture he has given us.

LECTURE.

Monday, May 13th, 1870.

MAJOR-GENERAL SIR J. LINTORN SIMMONS, K.C.B., R.E., &c., &c., in the Chair.

MILITARY TELEGRAPHY AND SIGNALLING.

By Captain R. H. STOTHERD, R.E., Instructor in Telegraphy, School of Military Engineering, Chatham.

I HAVE found it an extremely difficult matter to compress within the limits of an hour all that I feel ought to be said on the subject of Military Telegraphy and Signalling. In drawing up this paper, I have therefore confined myself to general principles, without attempting to enter into details.

Though telegraphy, in the form of visual signalling, has been employed from time immemorial for warlike purposes both on shore and afloat, it is only within about the last 15 years that the electric telegraph has been so used; and the great progress which has been made in the short period above-mentioned in the development of this branch of military science, may I think be fairly taken as a criterion of the importance of the part it is likely to play in future campaigns.

Telegraphs for warlike purposes may be divided into two classes.

1st. As applied to a permanent fortress.

2nd. As required for service with an Army in the field.

With regard to the first, the objects to be attained are—

1st. The rapid transmission of messages from some convenient central point, at which the Officer in command would establish his head-quarters, with certain points to be selected on the several permanent lines of defence.

2nd. Communication with outworks.

And 3rd. In the case of a sea fortress, the capability of communicating with shipping.

To do this, lines of electric telegraph should be established from head-quarters to certain points on the enceinte, from whence the communication would be continued by visual signalling. The electric telegraph in this case would be similar to an ordinary civil line of

telegraph, precautions being taken to place it in such a position as to be safe from destruction by an enemy's operations, and covered from the fire of his guns. For this purpose it would probably be necessary to use an underground line, buried at a considerable depth below the surface of the ground. The extensive system of works covering the Dockyard at Portsmouth, offers a very good example to illustrate our theory with regard to a permanent fortress. Thus the Hilsea and Gosport lines, the Horse Sand, No Man's, and all other detached forts, should be connected by a system of electric telegraph with headquarters, while visual signal stations, in connection with the electric telegraph and in extension thereof, should be established on all the advanced forts looking seaward, to communicate with shipping, and on certain points on the land defences, to enable communication to be kept up with a force which might at any time be thrown out to watch an enemy's proceedings. I would here remark that it would be quite impossible to work any system of defence by submarine mines, or, as they are commonly called, torpedoes, or any of the more delicate modes of determining the distances of ships in motion, involving simultaneous observations from the distant extremities of a long base, to advantage without a well devised system of electric telegraphy.

There is nothing very special in the system of electric telegraphy required for the purposes of a permanent fortress, and the visual signalling apparatus would be of the patterns which, with the very able assistance of Captain Colomb, R.N., and Major Bolton, late of the 12th Regiment, have been decided on as applicable for day and night signalling and communication with the Royal Navy, in connection with permanent works, viz., shutters, cones, and flags for day signalling, and lamps for night.

We have found by practice that the most perfect system of telegraphy for military purposes is that in which the electric telegraph has been combined with visual signalling, the latter forming a most important adjunct to, and extension of, the former, and this is equally the case whether applied to the requirements of a permanent fortress, or adapted for service with an army in the field. In either case the electric without the visual, or the visual without the electric system, is bereft of half its utility and efficiency. It is, therefore, necessary in considering the question to treat of both as essentially component parts of one system.

I now pass on to the second application of telegraphy for military purposes, viz., that adapted for service with an Army in the field. The objects to be attained by an equipment for such a service, are as follows:—

1st. A communication with the base of operations, which would form the main line from which all else should radiate.

2nd. The extension of this main line of telegraph, so as to keep up with the daily advance of an Army.

3rd. The establishment of telegraphic communications with a force detached for a special duty.

4th. The establishment of telegraphic communications from the centre to the flanks of an army in position.

5th. The connection of the outposts of an army by means of visual signalling, with the terminal points of the electrical part of the system.

And 6th. The means of communicating with facility with a co-operating naval force.

Before entering upon the discussion of the form of equipment best adapted to meet the objects in view, let us for a moment consider what has already been achieved by means of telegraphy. Commencing with the signal fires of savage nations, a gradual advance has taken place, passing through the several stages of improvement, indicated by the more modern patterns of semaphore, and culminating in the electric telegraph. Some system of telegraphy has always been more or less used in all ages. The news that the Austrian army, under the Archduke Charles, in 1809, was in motion, was communicated by a system of semaphores from the Austrian frontier to Paris, and within 24 hours of the despatch of that news, Napoleon was on his way to take command of the French Army, with which he soon occupied Vienna, and fought the battles of Aspern and Wagram. Again, the celebrated lines of Torres Vedras were provided with flagstaves similar to those of a coast-guard station, and adapted for the transmission of signals by naval flags. The Cossacks of the present day have a rough system of signalling adapted to their work, which consists in guarding an extensive frontier.

Recently no war of any importance has taken place in which the electric telegraph has not been used. It was used by the British in the Crimea, during the Indian mutiny, in China, in New Zealand, and in Abyssinia; by the French, during their recent campaign in Italy, as well as previously in the Crimea; during the Italian campaign in Southern Italy, in 1860, and at the siege of Gäeta, and subsequently during the campaigns in Lombardy; by the Spaniards, during the campaign in Morocco; by both Federals and Confederates during the recent rebellion in the United States; and last, though not least, by the Austrians and Prussians during the campaign in Holstein, and subsequently during that in Bohemia in 1866.

As an illustration of what was done on these occasions, one or two instances of which we have a few authentic details, will suffice to give an idea of what may be done in future.

During the Indian mutiny in 1857-8, Lord Clyde's head-quarters were generally in telegraphic communication with the seat of Government at Calcutta. There appears, unfortunately, to be no detailed account of the instruments and means employed in the operations by which this desirable result was effected. There is, however, a very short report, by the late Lieutenant-Colonel Patrick Stewart, C.B., R.E. (to whose unremitting energy its success was entirely due), published in the records of the India Office, which gives a general idea of what was done. As far as I have been able to ascertain, it seems that temporary lines were constructed, in continuation of the permanent lines of the country, to connect the head-quarters of Lord Clyde's force with the seat of Government. The permanent lines of the country being always along the main lines of road, which formed the communication with the base of operations, and which were conse-

quently, to a considerable extent, guarded and patrolled, interruptions to telegraphic communication, due to the rebel's operations, were extremely rare.

As regards the campaign in 1866, each of the two main Prussian armies operating in Bohemia had one unit of field-telegraph-equipment attached to it, a third unit was attached to the head-quarters of the King of Prussia, and a fourth was in reserve. Each unit carried 27½ English miles of wire, with a certain number of Morse recording telegraph instruments and batteries, was complete in all its details, and capable of erecting a line of electric telegraph as fast as the head-quarters of an army could march.

Thus equipped, the head-quarters of each Army appear to have been in constant communication with Berlin, and, through this latter place, with each other. The system adopted seems to have been to make connections with the permanent lines of the country, and to form temporary lines as required, using the field equipment for the latter purpose, as well as to supply any deficiencies occurring in the permanent lines till the latter had been repaired. Till within three or four days before the battle of Königrätz, the telegraphic operations appear to have been always well advanced; and though the wires did not actually extend up to the field of battle, there can be no doubt that the electric telegraph contributed to the Prussian success in no small degree. There appears to have been no difficulty in protecting the line, which followed the railways (the main lines of communication), and was consequently well guarded.

No system of visual signalling was used in connection with the electric telegraph, either during the Indian mutiny or during the campaign in Bohemia, and up to the present day, the Prussians have not organized any visual system. It is my firm impression that had the Prussians possessed a visual system during the Bohemian campaign, they would have been able to have communicated so much further to the front on each line, that much of the anxiety at a critical moment of the battle of Königrätz as to the position of the Army of the Crown Prince of Prussia, would have been avoided.

Again, for the Abyssinian campaign of 1867-8, the telegraph equipment provided was organized in two divisions, viz,, a light line, formed of a light insulated electric cable, to be laid as fast as the force advanced, and of which a system of visual signalling formed a part; and a reserve line, partaking more of a permanent character, to be erected at leisure in rear of the advancing Army. In consequence of want of transport, the light line, with the exception of the visual signalling apparatus, was abandoned altogether; and for the same reason great difficulty was experienced in carrying the materials, especially the poles, required for the semi-permanent line, and its efficiency was consequently seriously impaired. From the causes mentioned, the progress of erection was much slower than it might have been; and when the line was erected, considerable inconvenience and interruption to signalling was experienced, principally from the breaking down of the make-shifts which it became necessary to substitute for telegraph-posts, suitable poles not having been obtainable in the country. The

number of men available for working parties appears also to have been very limited; towards the end of the campaign, when more men were available, as much as ten miles were erected in a day; there seems to be no doubt, therefore, that, with adequate means, it might have been carried, if not absolutely as far as Magdala, very much nearer to it than was actually done. Except at first, there appears to have been very little difficulty consequent upon the interference of the natives with the line; their motives for touching it appear to have been curiosity, or a wish to become the possessors of the copper wire of which it was formed. The telegraphers and signallers for working this line were, with the exception of one or two natives from Bombay, supplied from the School of Military Engineering at Chatham. Two Officers and 37 Non-Commissioned Officers and men (25 for the electric telegraph and 12 for visual signalling) went from Chatham. The natives from Bombay were intended for working the stations in the plain, where the great heat rendered it undesirable to employ Europeans. Captain (then Lieutenant) St. John, R.E., was appointed by the Bombay Government to superintend the whole. He had been for some time employed on that portion of the Indo-European telegraph passing through Persia, and was consequently well qualified for the duties required of him. Much credit is due to Captain St. John, and the Officers and men under his command, by whom this line was erected, and who, by their zeal and energy, accomplished a very great deal with very inadequate means.

Notwithstanding the numerous drawbacks, occasioned by faulty materials employed in the construction of this line, it proved itself of very great value. 7,848 messages were sent by it from the time its erection was commenced till the termination of the campaign, a period of five months; the line was incomplete and in progress of extension during this time. This is evidence of its value. The visual signalling apparatus was carried to Magdala, and was found of the utmost use in the transmission of intelligence on numerous occasions.

I have been unable to obtain any authentic details of the telegraph-equipment employed in other campaigns, where this important adjunct to modern warfare was used. We have, however, sufficient for our purpose to enable us to form an opinion as to what the nature of future military telegraphic operations would be, and what kind of equipment we should require to accomplish the work required, with the greatest advantage, ease, and rapidity.

A line of electric telegraph is somewhat in a similar position to a railway as regards modern warfare, A force retiring through its own or a friendly territory would be in full possession of both telegraphs and railways, and could use them to the utmost, and by thoroughly destroying them, would deprive an enemy of all advantage to be derived from them till re-constructed. For defensive purposes, therefore, we may fairly infer that the electric telegraph would be of very great advantage, as admitting of the transmission of orders and intelligence with a celerity hitherto unattainable.

An attacking force, on the contrary, must be prepared to find everything in the shape of railways and telegraphs at least only in a state

of ruin on the line of advance, and must carry the means of re-establishing them with the utmost rapidity, and when re-established they must be thoroughly patrolled and guarded to ensure efficiency. The main line of telegraph would be established on the principal line of communication with the base of operations, which, whether a railway or simply an ordinary road, would necessarily be more or less guarded, and the same guard that protected the road, would protect the telegraph line. This remark is especially applicable to a railway, the value of which, as a means of communication with a base of operations, would essentially depend upon the efficiency of the protection afforded to it.

From the experience of the Bohemian Campaign, it would seem fair to assume, that combined military operations, by columns moving on lines at a considerable distance from each other, can be carried on by the aid of the electric telegraph and visual signalling, with infinitely greater precision and certainty of result than has hitherto been possible. Again, it is no inconsiderable advantage to be able to transmit orders and intelligence in a few minutes over distances which, under the old *régime*, could not have been accomplished without hours of hard riding.

We now come to the all-important point of the nature of the equipment required for service with an army engaged in a campaign.

After a careful consideration of the nature of the objects to be attained, it seems to me that such an equipment should consist of two divisions, a light line, capable of being put together as fast as infantry can march, and of which a system of visual signalling should form a part; and a reserve or semi-permanent line, partaking of the nature of an ordinary civil line of telegraph, for use along the main line of communications to the base of operations.

In carrying out the system decided on by them, the Prussians divide their light line into units, and in this respect we cannot do better than follow their example. With the exception of a few unimportant details, the unit of light line which seems best adapted for our service, is very much like the Prussian. A very interesting account of the Prussian Field Telegraph is given by Captain Webber, R.E., in the sixteenth volume of the Professional Papers of the Royal Engineers, and a further detail of the improvements introduced since Captain Webber's paper was written, has been furnished by Lieutenant S. Anderson, R.E., who was present during the field manœuvres of the Prussian Army last summer. The Prussians consider their field telegraph so important, that for the manœuvres in question, it was put on a war footing.

We have proposed that our unit of Field Telegraph Equipment should consist of three travelling telegraph offices, and twelve wire and store waggons, carrying 36 English miles of insulated wire and the necessary tools, &c., for construction of the line; these with three general service waggons, three artificers' waggons and a field forge, complete the establishment.

The form of travelling telegraph office is shown in Fig. 1. It is simply a small omnibus mounted on springs, drawn by two horses, carrying two Morse recording telegraph instruments on a small table,

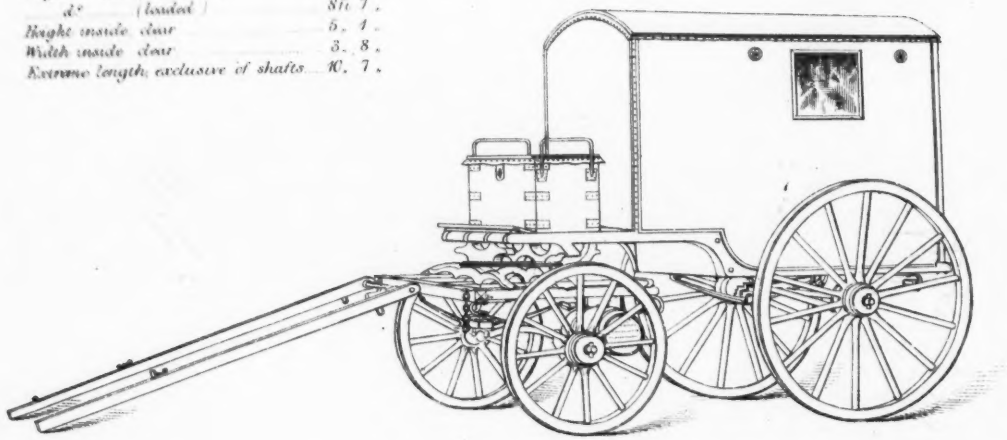
always ready to commence work the moment the earth and line wires are attached. Two telegraph batteries, of a form designed by Quartermaster Sergeant J. Mathieson, R.E., a modification of Daniel's form, are always in position under the table carrying the instruments, and ready for work. Four spare Morse telegraph instruments, two recording and two sounding, and two spare batteries are carried in each travelling office, to supply deficiencies, and to enable branch lines to be thrown out if required. Besides these, a set of visual signalling apparatus, tools of various kinds for the repair of the line and of the instruments themselves; earth plates, which are simply plates of copper for establishing earth connections to complete the electrical circuit; a tent, a small set of cooking utensils, and picket ropes, &c., for the horses, form a part of the equipment of this waggon, so that if detached, as it no doubt often would be, the men attached to it would be able to shift for themselves. This waggon would also carry the kits and arms of the men, the latter however in such a position as to be readily available at a moment's notice in case of emergency. This waggon, with stores complete, weighs 22 cwt.

To each office-waggon are attached three telegraphers, one driver and one spare man, the latter to assist generally in pitching and striking camp, cooking, &c., when on detached duties. On the march, except on very bad roads, the men would be carried on the waggon; the limber box in front affording them room to sit. The object of this is to bring the men into camp fresh, as their duties would commence just when those of other soldiers were, as a rule, over. The Prussians at first mounted their telegraphers on horseback, but they found that, even in this way, they were not sufficiently fresh for their work, and it entailed a further addition of men simply to look after the telegraphers' horses. Under their present system, the Prussians carry their telegraphers in a sort of cabriolet, drawn by two horses, but I prefer carrying them on the telegraph office itself, as they would thus be always close to their work. I should prefer, if necessary, putting four horses into the telegraph office, and carrying the men on it, to carrying them in a separate carriage. By such an arrangement we should not require more horses than under the present Prussian system, and we should still require fewer than if the men rode. Hitherto we have found two horses sufficient. The springs make an enormous difference in the draught. One of these telegraph offices complete, with the men mounted on the waggon, weighs about 28 cwt., yet I have seen two horses take this load along easily and without showing the slightest distress, while four, on the same road, with a load of 32 cwt., on a carriage without springs, were evidently obliged to use much greater exertion. A travelling office complete marched from Chatham to Canterbury, a distance of 27 miles, in $5\frac{1}{4}$ hours, without distress to the pair of horses drawing it.

We have adopted the Morse form of telegraph instrument, because, by it, every message is recorded, a matter not to be slightly regarded in the transmission of military orders. Probably for the same reason, this form of telegraph instrument has been recently adopted by all Continental armies for their field equipment. Bearing in mind the

Height to roof (unloaded)	8ft 8in
do (loaded)	8ft 7 .
Height inside clear	5 . 4 .
Width inside clear	3 . 8 .
Extreme length exclusive of shafts	10 . 7 .

FIG. 1



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necessity for simplicity in all connected with the conduct of warlike operations, we have endeavoured to do away, as far as possible, with all delicate complications of construction, such as attached galvanometers, connections for translation of messages, &c., while at the same time they have been arranged to pack in the smallest possible compass for stowage and transport. They are, moreover, very light. They are adapted for use with battery power or with a magneto-induction current; and as sounders as well as recording instruments. The object of using these instruments as sounders, is to economise the paper strips on which the messages are recorded; it would be unnecessary to record unimportant messages, for example those giving instructions for the working of the line might fairly be sent by sound without inconvenience. The Morse sounding instruments are similar to the others, without clockwork or recording arrangements, and are intended for use in the examination or construction of the line, and for any other purposes where it is not necessary to record the messages. These instruments have been tried by knocking them about both on pack-saddle and wheeled transport, and hitherto they have only been disarranged by the shaking, to such an extent, that a few turns of the adjusting screws have made them ready for work in two or three minutes. They were made by Messrs. Siemens, Brothers, of Charlton, from general ideas sketched out for them, and are very excellent specimens of workmanship.

The telegraph batteries employed, were specially designed for the equipment by Quartermaster Sergeant Mathieson, R.E. They are a form of Daniel's battery, that is to say, zinc and copper plates in a saturated solution of sulphate of copper. The improvements due to Quartermaster Sergeant Mathieson are the compact form of the cell and the arrangement to prevent the escape of the liquid in case of an upset. This latter is attained by covering in the top, leaving only a small pinhole for the escape of the gas generated by the action of the battery. We have tried these batteries against the Marié-Davy form, used by the Prussians for their field equipment. For the first day or two, the Prussian battery proved slightly the best, but after that, Mathieson's beat it, and after a few days, the Prussian battery was nowhere; in fact, it required to be touched up and put to rights, while Mathieson's remained as good as ever for work. This circumstance, together with certain other defects inseparable from the Marié-Davy form of battery, one of which is the soldering on of the copper strip, connecting the plates, to the carbon element, an operation which would be extremely difficult in the field, has induced us to adopt Mathieson's as the form of battery for our equipment. This battery has been tried severely both by pack-saddle and wheeled transport, and has stood the rough usage and shaking remarkably well. These batteries have been made for us by the Indian Rubber, Gutta Percha, and Telegraph Works Company of North Woolwich, and are extremely well finished.

The earth-plates are of oblong form and made of copper. They are 18 inches long, 6½ inches wide at the top and tapering to a breadth of 3½ inches at the point. They are capable of being used either by

digging a hole and burying them, or by driving a strong iron wedge of similar shape into the ground and subsequently slipping the copper earth-plate into the hole so formed. A small barrel of water is carried with the waggon to pour on the earth-connections when the ground is very dry. The circuit from the earth-plates to the instruments is made by a copper wire.

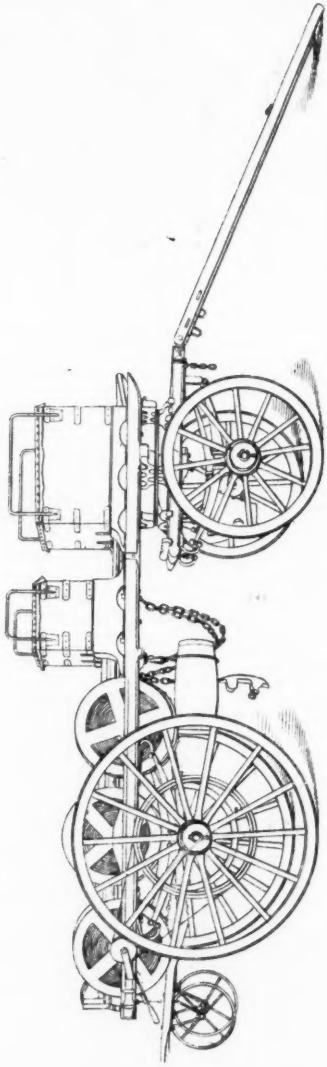
A set of small tools for repair of the telegraph instruments, arranged in a leathern roll, also some spare springs, &c., are carried in the travelling office.

The only other speciality conveyed in this carriage, is a set of day and night signalling apparatus, the nature of which will be detailed in treating of visual signalling. The other articles are simply a selection of smiths', tinsmiths', and carpenters' tools, of the nature required in the construction of a line of telegraph, also a spade, pickaxe, crowbar, jumpers, &c., which, with a tent and camp equipment, completes the arrangement.

The wire and store waggon, Fig. 2, is a four-wheeled carriage mounted on springs, designed to carry three miles of insulated wire on six drums, with the necessary tools and apparatus for the construction of a line of telegraph. Eighteen light iron telegraph-poles and a light ladder lie in the space between the rows of drums. These poles are intended for use at road-crossings, where constant superincumbent traffic would in time destroy the insulation of the wire. Under ordinary circumstances, it is simply laid on the surface of the ground; at minor crossings it may be buried, a very small trench being quite sufficient to secure it from injury. Two limber boxes on the front of this waggon carry the small stores for the construction of the line as well as the arms and kits of the men, the former, as before, readily accessible in case of emergency. These limber boxes also form seats for the men when a forced march becomes necessary. A light wheelbarrow is carried beneath this waggon to enable the line to be paid out in situations where the waggon itself could not go. A canvas cover is drawn over the whole when not in use. The weight of this carriage complete, is 32 cwt.

The conducting wire is a most important item in any line of telegraph. For the equipment we have selected a strand of 3 No. 20 copper wire, insulated with Indian-rubber to a diameter of $\frac{2}{10}$ths of an inch, and with an outer covering of tarred tape laid on in two thicknesses with a long twist, the first in one direction and the second in the opposite, by which means considerable tensile strength is obtained. Two men pulling with all their might at a piece of this insulated wire, the end of which was made fast to a fixed point, failed to break or even do it any apparent injury. This gives a practical idea of its tensile strength. Indian-rubber has been selected for the insulating material, in consequence of its great resistance to injury. We have had every gun and waggon of a field battery of artillery, as well as of the A, or pontoon, troop of the Royal Engineer Train pass over this insulated wire, laid on a hard flinty road, without doing it any apparent injury. Some of the pontoon waggons, which were of the old pattern, weigh complete more than two and a quarter tons. This

FIG. 2



Height to iron handrail { unloaded } ..... 6 ft. 6 in.
d.° { loaded } ..... 6 . 5 ..
Extreme length, exclusive of shafts ..... 13 . 0 ..

is proof positive of its resistance to injury if necessarily subjected to such usage. Either Hooper's core, now so well known as a di-electric for submarine cables, or Gray's core, manufactured by the Indian-rubber, Gutta-percha, and Telegraph Works Company, North Woolwich, the latter somewhat similar in construction to the former, and both being combinations of vulcanized Indian rubber, are excellent for the purpose required. The first Prussian field equipment was fitted with a conducting wire insulated with gutta-percha, with an outer protecting covering of copper tape, and designed to be laid on the ground. This is an excellent combination, if, when once laid down, it can be allowed to remain; and for short submarine cables it is much used by the Austrians, to connect the islands in the Adriatic, with excellent effect. If, however, it is constantly coiled up and paid out again it does not answer, the gutta-percha soon becomes brittle by dry heat and cracks during the process of constructing a line, leaving the conductor bare, and consequently no longer insulated. The passage of a waggon over the Prussian wire is fatal. It was tried, with several other specimens, in a similar manner to the cable adopted by us, but the first gun which passed over it, destroyed the insulation beyond repair. The Prussians have since discarded this form of conductor in favour of an air line carried on poles. This latter, however, possesses some serious defects, one of which is that the general line is not sufficiently high to permit a mounted man to pass freely under; it also takes a much longer time to construct than a ground line, and is quite as easily destroyed by an enemy, and is more conspicuous. After due consideration, we have therefore decided to adopt a ground line.

To form a line with the insulated wire described, it is only necessary to pay it out from the waggon, or, where the waggon cannot pass, from a hand-barrow, and let it lie on the ground. When the wire on one drum is expended, that on the next is attached to it by a very ingenious connector invented by Quartermaster Sergeant Mathieson, R.E. By this little apparatus an insulated joint may be made by a practised man in less than a minute. The second drum of wire is then paid out similarly to the first, and the same process is continued till all are emptied.

Light iron poles are carried to support the wire across roads abutting on that along which the telegraph is constructed. These poles are made of tubular iron in two lengths: the lower length is 1 inch in internal diameter, 10 feet long, and furnished with a solid-pointed shoe at one end to enable it to be pushed into the ground. The top, which is 9 feet long and $\frac{7}{8}$ths of an inch in external diameter, fits for transport inside the lower portion. For use it is taken out, reversed, and the two parts fitted together with a kind of bayonet-socket arrangement, forming a pole 18 feet long. A wooden catch to carry the wire is pushed into the top of the pole and two cord guys are fastened to thumb-screws attached to it within 2 feet of the top; holes are made with a jumper, at the positions where the poles are to stand on each side of the road; the wire is fixed after measuring the distance between the supports and adjusting it, so that it shall neither be too tight nor

too slack, and the poles are raised together and each pushed into its respective jumper hole. The guys are then made fast to two iron pickets, one on each side and a little retired from the road to be crossed, and the conducting wire itself is made fast to a third iron picket, so as directly to take up the strain on the wire suspended over the road. This completes the operation. With practised men a pair of poles can be put together and erected, with wire suspended, guys made fast, and everything complete, in from three to four minutes.

Each wire and store waggon carries one Non-Commissioned Officer and six men. These waggons work in pairs, one lays the line wire continuously while the second follows and erects the poles. Each Non-Commissioned Officer and man has a particular duty told off to him, and the whole has been reduced to a regular system of drill. In forming the line, the Non-Commissioned Officer in charge tests the continuity of the circuit at the end of every half-mile, and also, by means of his sounding instrument, is able to convey any information to the point from whence the line started and to receive the same in return. In this way a continuous communication could be kept up, if required, from the moment the line started from the initial point; it would only be necessary to leave a mounted Non-Commissioned Officer at the end of the first half-mile till the second was paid out, when the two could be joined together and he could trot on to the front, a second non-commissioned Officer taking up a position at the end of the second half-mile till the third had been paid out, and so on, *ad infinitum*. Many systems have been devised with a view of keeping up telegraphic communication by converting the wheel of the waggon carrying the telegraph instruments, into an earth connection, but there are many difficulties to be overcome. At best, the earth connection obtained can only be a very indifferent means of completing an electrical circuit as compared with a properly constituted earth-plate, and such a combination introduces complications which are not desirable in any military equipment.

In certain situations, as for example in carrying a line through a village or through a wood, advantage may be taken of walls or trees for suspending the wire in positions where it is desirable that it should be raised above the ground. For this purpose each wire waggon carries a certain number of iron hooks, which are capable of being hammered into walls or trees, and on which the wire may be suspended. In this way poles may frequently be saved.

A light ladder is carried in each wire waggon. This is made in two parts, connected by a hinge, so as to form a step-ladder; when a greater length is required the two parts are pushed up into one continuous length, and fastened together by means of keys, thus forming a ladder 18 feet long. This ladder has been found extremely useful and handy.

A light wheel-barrow, arranged to carry a single drum with its wire, forms also a part of the equipment of the wire waggon. The object of this apparatus is to enable the wire to be paid out in situations where the wire waggon itself could not travel. The front of this wheel-barrow is fitted with an eye, into which a lasso can be hooked, so that horse-power may always be applied in drawing it. Where the ground is

so steep or rough that it is impracticable to use the wheel-barrow, a drum of wire is placed on an iron spindle, and carried by two men, one on each side, and paid out as the men move forward. This spindle has been found more handy and easily worked than a hand-barrow, which was at first used with the equipment. The men prefer it, which is a good criterion of its advantages for practical use.

By the process described, a line of telegraph may be constructed at the rate of from 2½ to 3 miles an hour; with very well practised men, and on a good road, a speed of nearly 4 miles an hour has been attained; but I prefer the smaller figures, as they give a better idea of the average speed which may be kept up under ordinary circumstances.

In dismantling a line, the operations described for its construction are simply reversed. The wire waggons, as before, work in pairs—one goes in front, with its working party, and takes down the poles, which are quickly stowed away in their proper places, while the second follows and reels up the wire. Along a road, or on any ground where the wire waggon can travel, this process of reeling up is performed mechanically by a very ingenious arrangement, designed by Troop Sergeant-Major Williams, of the Royal Engineer Train. It consists of a vulcanized Indian-rubber or leathern strap, working round a drum, attached to one of the hind wheels. As the carriage moves forward, this strap conveys motion from the wheel to a pulley in connection with a clutch, which latter fits into a corresponding arrangement on the end of the spindle, carrying the rear drum of the waggon, to which the rotatory motion of the wheel is thus conveyed. As the wire is gradually reeled up, it is easily understood how the diameter of the drum on which it is coiled, gradually increases. To obviate any bad results which this circumstance would necessarily entail, the apparatus is so arranged that, when commencing to reel up on an empty drum, each revolution of the latter may just coil the wire up as fast as the waggon advances, the axle of the drum being then at its minimum. As the plies of wire are gradually wound on the diameter of the axle increases, and each revolution would consequently, after a little time, take up more than the length required in proportion to the advance of the waggon; this contingency is provided for by a lever in connection with the clutch, by which the latter can be thrown into or out of gear at a moment's notice. When the wire is getting reeled up too quickly, the apparatus is thrown out of gear, the revolution of the drum ceases, and the wire is not reeled up at all. When a sufficient amount of slack has been left behind, the apparatus is, by means of the lever, thrown into gear, and the reeling up, recommenced. Practically this arrangement has been found to work remarkably well, and, with well practised men, a very little use of the lever is required, till the very end of the length of wire is nearly reached, when of course the diameter of the drum is at its maximum.

In dismantling a line of field electric telegraph, each man has a specific duty to perform, and the whole is, as in the case of the construction of a line, reduced to a simple system of drill; a line may be dismantled more quickly than it can be formed, and the average for

this operation (dismantling), may be put down at nearly four miles an hour.

A suggestion of Mr. Lombard, one of the *employés* at the Royal Engineer Office at the Permanent Barracks, Aldershot, is well worthy of consideration. He proposes to provide 10 men, either cavalry or infantry, for each mile of line, each man to carry 200 yards of insulated conducting wire, making a total of 2,000 yards, or, as a considerable amount of slack would be required in practice, roughly, one mile for the 10 men. To form a line, each man would lay out his 200 yards of wire in the direction required, in succession, connecting it carefully to that of his next neighbour. In this way it is easily understood how a line of telegraph might be very quickly constructed, or still more readily dismantled, the latter a most important matter in the event of a sudden retreat becoming necessary. A Non-Commissioned Officer, in charge of each 10 men, carries a portable telegraph instrument, which he attaches, with an earth connection at the end of the line, and by which messages may be received or transmitted with facility. This mode of operation is not applicable to the construction of a main or even a principal branch line of telegraph, which could be more efficiently done, at a sufficiently rapid rate, by means of the waggons of the equipment. It is, however, very applicable to such work as following up a reconnaissance pushed forward, to convey intelligence therefrom to the head-quarters of an Army. Its chief defect is the number of joints or connections necessarily made, each to a certain extent productive of the chance of interruption; these must consequently be put together with great care.

This proposition has not yet been tried, but a report and estimate has been forwarded to the War Office, and as the sum required to be expended is not great, it is to be hoped that an experiment may be made.

The other waggons of the equipment, viz., the field forge, artificers, and general service waggons, have nothing special in their construction, and need not, therefore, be described. They should, however, be all mounted on the same wheels, and provided with the same axles as the carriages of the Royal Engineer Train, viz., 5 ft. hind, and 3 ft. 6 in. fore wheels; width of tire, 3 in., round iron axles, with third class arms of Ayshford's pattern, and a 5 ft. 8 in. track.

In designing the telegraph instruments for this equipment, simplicity has been always kept carefully in view, because it is essential that delicate or complicated arrangements should be avoided in warlike operations. All delicate galvanometers and connections recording and passing on a message, called in telegraphic language translation, have been omitted, not from any want of appreciation of the value of such combinations, but simply to ensure simplicity. It is probable that the more delicate instruments might be used with advantage on the main line, if, when once put in position, they could be allowed to remain undisturbed for a considerable time, and for which service special instruments might be provided. As an instance, however, of the necessity for simplicity, I may mention that the attached galvanometers and other more delicate combinations of the instruments sent

out to Abyssinia soon got out of order, and became absolute sources of difficulty and trouble, and Captain St. John, R.E., in his report on the telegraphic operations of that campaign, recommends that for future military service, all attached galvanometers and other complications should be omitted. The telegraph instruments sent to Abyssinia were simple Morse recording instruments of the ordinary commercial pattern, and not in any way specially fitted for military service.

I now pass on to the visual signalling apparatus, which it is proposed should form a part of each unit of field telegraph equipment. In order to effect the objects in view, provision must be made for day and night signalling, and by means of this apparatus, the very important part of communication with a co-operating naval force, must also be performed.

For day signalling, flags 4 feet square, on poles as light as they can be made consistent with strength, have been adopted. The flags are either entirely black and entirely white, or black and white combined, to suit every variety of background. The messages are sent by code, the code used being a combination of the original Army code and the Naval code for boat service; it is entitled "The Army and Navy Code," and is published by authority, and issued to Her Majesty's ships and to all military stations. The numbers are sent by long and short waves of a flag, a long wave indicating a dash (—), or long element, and a short wave a dot (.), or short element. These dots and dashes are similar to those of the ordinary Morse Telegraph Alphabet. The numbers used to transmit the code messages are as follows:—

1. .	6. —
2. . .	7. . —
3. . . .	8. — .
4.	9. . . —
5.	0. — . .

These, with a few combinations of dots and dashes, indicating certain special call-signals, are all that is necessary for the transmission of any message that may be required. In addition to the general code, which consists of groups of *four* figures, there is a spelling code, embracing certain combinations of letters indicated by groups of *three* figures, the last hundred numbers, from 900 to 999, being devoted to a code of such words as "all, the, or," &c., an army evolutionary code (embracing also a few messages exclusively for signallers), indicated by groups of *less than three* figures; also a list of the numbers of Her Majesty's ships, an horary code, a geographical code, to be filled in for local names, and capable of being adapted to the particular district for which the code is required, and an alphabet, which is the same as that used for spelling a message, without a code, in Her Majesty's Navy. There is also a boat evolutionary code, consisting of groups of *less than three* figures; the chances being considerably against the Army evolutionary and boat codes being required to be used together, they have each been arranged for groups of *less than* three figures. Should an exceptional case occur, in which it was necessary to use the

two together, a preconcerted preliminary signal would prevent any confusion; for boat service there is also a compass code.

Time will not admit of my going minutely into the mode of using this code book, but full directions are given in the book itself, as well as in the Manual of Instruction of Army and Navy Signalling, published by authority.

For night-signalling, lamps must be employed. These have been arranged in a portable form, and are constructed to show long and short flashes of light, corresponding to the long and short waves of the flag for day-signalling. The light is produced by throwing a a jet of fine powder, composed of a mixture of powdered magnesium, powdered resin, and lycopodium through the flame of a spirit-lamp, and is of an extremely brilliant nature. This mixture is blown, as it were, through the flame by means of a pair of bellows worked by hand. The powder is composed of the materials mentioned in certain proportions; it is numbered from 1 to 4, according to quality. No. 1 contains 1 of lycopodium, 1 of resin, and 1 of powdered magnesium; No. 2, 1 of lycopodium, 1 of resin, and 2 of powdered magnesium; No. 3, 1 of lycopodium, 1 of resin, and 3 of powdered magnesium; and No. 4, 1 of lycopodium, 1 of resin, and 4 of powdered magnesium. The light is most brilliant when the quantity of magnesium is greatest; No. 4 is therefore arranged to be used for actual service and long ranges, while a mixture containing less of the most expensive material (magnesium) answers every purpose for less distant signalling and for practice.

Each signalling party consists of a Non-Commissioned Officer and two men, and, in very important positions, an Officer may always be employed with advantage. In addition to the flags and lamps described, each should be furnished with a good telescope on a small portable stand, a pair of field glasses, a code book, a message book, and some small stores for keeping up the light for night use and general purposes.

The articles of equipment described, are similar to those sent out to Abyssinia for visual signalling purposes, on which, however, improvements have been made. The patterns decided upon are chiefly due to the labours of Captain Colomb, R.N., and Major Bolton, late of the 12th Regiment, who were specially attached to the School of Military Engineering at Chatham, with a view to the development of a good system of Army and Navy signalling. These Officers, with whom was associated Lieutenant C. H. C. Halkett, R.E., made out the signal code book, and anyone who has used it will, I am sure, bear testimony to its completeness for the purpose required.

Messages can be sent, both by the electric telegraph and visual signalling, in cypher. In this way an enemy would be unable to make use of any communications falling into his hands, unless in possession of the key, and the amusing *contretemps* which so frequently occurred during the recent American war, could not take place. For the transmission of ordinary written or telegraphic messages a very simple little apparatus, designed by Major Bolton, has been adopted. It possesses the advantage that if, by any chance, it should fall in the hands of an

enemy, it is still quite useless without the key. It is applicable to written messages as well as to those sent by telegraph. The cipher employed in the transmission of messages by code is precisely the same as that used in the Royal Navy.

The table attached to this paper gives the organisation of a unit of field telegraph equipment, which has been drawn up on the basis of the existing troops of the Royal Engineer Train, that having been found the most efficient and economical combination. This organization was tried, as far as circumstances would admit, last summer at Aldershot, and was found to answer very well. It received the approval of the Officers in immediate charge, as well as that of Lieutenant-General the Hon. Sir J. Yorke Scarlett, G.C.B., commanding the division. In general principles it is very similar to that of the Prussian unit of field telegraph equipment, though it differs from the latter in some of the minor details.

I must now turn for a moment to what I have termed the "Reserve Telegraph Equipment." The work to be performed by this division of the equipment would be the construction and maintenance of a substantial permanent line of telegraph along the main line of communication of a force advancing into an enemy's country. The repair and reorganization of existing lines would also form a part of their duty. These lines would generally be destroyed by a retreating enemy, and it is probable that, in most cases, the work to be performed would amount to an entire re-construction. The light line of telegraph, which would be used in the first instance, should be replaced as rapidly as possible by a semi-permanent line and passed to the front.

In order to be effective, this main line of telegraph should be of the most substantial description and composed of the best materials. The experience of the Abyssinian field telegraph proved this to be necessary, and, in civil lines of telegraph, the highest efficiency is only attained by the utmost care in construction and working, and the employment of the very best materials. Weather has a very marked effect on the working of a line of telegraph. A line constructed of moderately good or even defective materials will work in fine weather as well as one composed of the very best, but put them to the test of a storm, and it will be found that the carefully-made line will be in working order and fit to transmit messages to any extent, while the less carefully-constructed line will have ceased to have the power of transmitting messages at all. This is no theoretical assertion, but is borne out (on the authority of Mr. Culley, late electrician to the Electric and International Telegraph Company, and now employed on the Post Office telegraphs) by the working of the permanent lines of telegraph of the United Kingdom. Having, therefore, the impression that the main line of telegraph, connecting an Army in the field with its base of operations, should, to be of use, be always reliable and ready to send messages at all times and in all weathers, I am of opinion that the very best materials and workmanship should be employed in its construction. I wish to be thoroughly understood on this point, because I have more than once heard opinions expressed, that for a military line of telegraph, extreme care and excellence of materials are not

required. I believe on the contrary, that it is just the position in which a first-rate line is required. Where the best materials are not obtainable makeshifts must of course be used, but it will not do to construct a line of inferior materials, simply because it is a military line, when, at a slight additional expense, the best materials could have been made available.

Time will not admit of my going into the details of men, stores, and apparatus required in the construction of a main line of telegraphic communication. Suffice it to say that it would depend, in a great measure, upon the nature and resources of the country in which the campaign was to be undertaken, and should be so organised as to admit of the construction of a substantial line of telegraph of the very best description. Large reserves of materials should be provided at intervals along the line for repairs, as it is more than probable that damage might be done to it by an enemy's operations.

The use of the telegraph for strategical purposes has been already practically exemplified during the campaigns alluded to in the commencement of this paper; its use, as applied to tactics, has still to be worked out. I think however that, with such an equipment as I have roughly sketched out, there would be no difficulty in applying the system to the latter, as successfully as it has already been used with the former movements of an army.

Assuming that the main line of telegraphic communication of an Army had been established up to a certain point in its rear, it would become necessary to start from that point and so to dispose our light field lines and instruments as to fulfill the following conditions:—

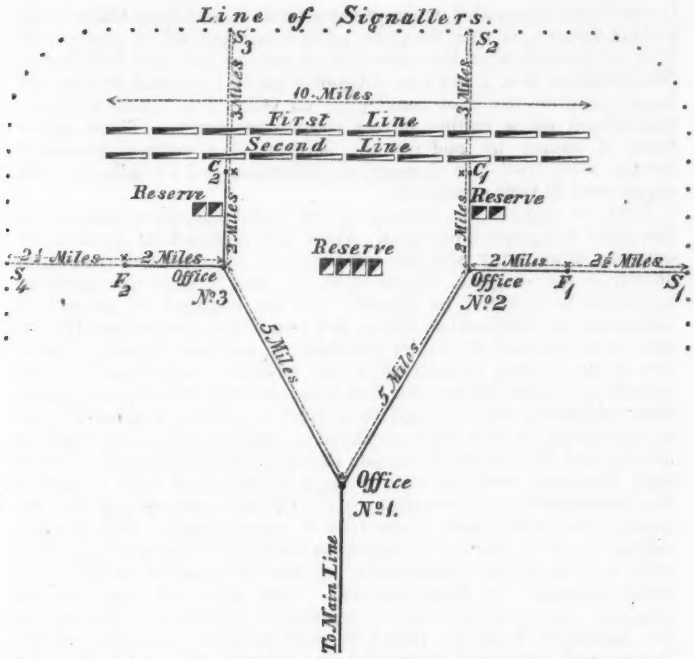
1st. To connect the field line with the main line of communication to the rear.

2nd. To transmit intelligence and orders from the outposts covering the front of an Army to a certain point in rear of its position.

3rd. To transmit intelligence and orders from its flanks to the same point.

Each unit of field telegraph equipment is divided into three sections, each consisting of one travelling office and 12 miles of line wire, with the necessary carriages and apparatus.

To form a line, No. 1 section would connect with the main line of communication and pay out wire to the point (see accompanying diagram), where No. 1 Office is to be stationed. From No. 1 Office, No. 2 section would form a branch line to the right, and No. 3 section a similar line to the left; each would run out a line 5 miles in length in the direction of the right and left centre of the force in position to the points where Offices No. 2 and 3 are shown:—



The station of No. 1 Office is supposed to be in rear of the point where the reserves are concentrated; the stations of Nos. 2 and 3 in rear of the reserves of the right and left wing. From Offices Nos. 2 and 3 two fresh branches would be started, one on each side in the direction of points in the rear of the right and left wing, indicated in the diagram by the letters C_1 and C_2, the other lines being in the direction of the flanks of the force to the points F_1 and F_2. Each of the two lines emanating from Offices Nos. 2 and 3 would be two miles long, making, with the five miles paid out in rear of those offices, a total of 9 miles of wire expended from each section, leaving a reserve of 3 miles on each branch for repairs and contingencies. This completes the electrical portion of the combination.

It will be noticed that the lines are all kept in rear of the troops in position. The object of this is, that in the event of an order to retreat, they may be reeled up and got out of the way before the troops had so far retired as to become entangled with the waggons performing this duty. The wire can be reeled up easily, at the rate of 4 miles an hour, and, on an emergency, can be reeled up at a trot on a good road; there is, therefore, no danger of being too slow, provided due notice is given to retire. It will be observed, too, that if the stations

C_1 and F_1 are dismantled, messages could still be sent from Office No. 2, a short distance in their rear, the latter being retained in position as long as possible after the more distant stations had been withdrawn. Should Offices Nos. 2 and 3 be obliged to retire, they could be attached to any point on the lines converging on Office No. 1, and messages transmitted till a further retreat became necessary. These operations of reeling up and retiring, in rear of a retiring column of troops, were tried last summer, at Aldershot, and no difficulty was experienced in their execution.

Next, as regards the disposal of the visual signallers attached to the Field Telegraph Equipment. These are intended to connect the outposts of an Army with the extremities of the electrical system, as shown in the diagram, where S_1, S_2, S_3, and S_4 show the positions in which they would be placed. We are engaged at present in instructing at Chatham, an Officer and two Non-Commissioned Officers from each regiment of cavalry and infantry, and each brigade of artillery in the service, as instructors and assistant instructors in visual signalling. These Officers and Non-Commissioned Officers, on rejoining their regiments, are supposed to instruct a certain number of men in each corps, so that when employed on outpost duty, they would be able to send information by signal; thus any corps on whom the outpost duty devolved, would at once arrange its signallers with a view to the transmission of information to the Officers commanding the outposts, who would place themselves in communication with the signallers S_1, S_2, S_3, and S_4, belonging to the Field Telegraph Equipment, with a view to the transmission of such information as they may deem desirable to head-quarters. The series of dots on the diagram represent the line of regimental signallers. In practice the signallers would be placed in such positions, according to the formation of the ground, as would best suit their work, and at distances, according to the clearness or otherwise of the atmosphere, not generally exceeding four or five miles.

The organization of the equipment described, does not provide for the collection of information; this must be done, as heretofore, by videttes, pickets, and Staff Officers, and the telegraphic system must only be regarded as a means of rapid transmission. In practice we have found that the attention of signallers is amply occupied in the performance of their legitimate duties, viz., the transmission of messages, and any attempt to combine the duties of collection and transmission has not been found to work satisfactorily.

It is again a great mistake to suppose that the use of visual signalling will, in any considerable degree, enable us to dispense with aides-de-camp and mounted messengers. At short distances these latter will still be as necessary as ever, just for the same reason that in addressing a gentleman across a room, it would not be advantageous to send a letter by post. Telegraphy and signalling come into play at distances and under circumstances where mounted messengers are comparatively useless; by the former (telegraphy and signalling), we are supplied with a new and powerful agency, by the proper use of which we can produce results unattainable by other means.

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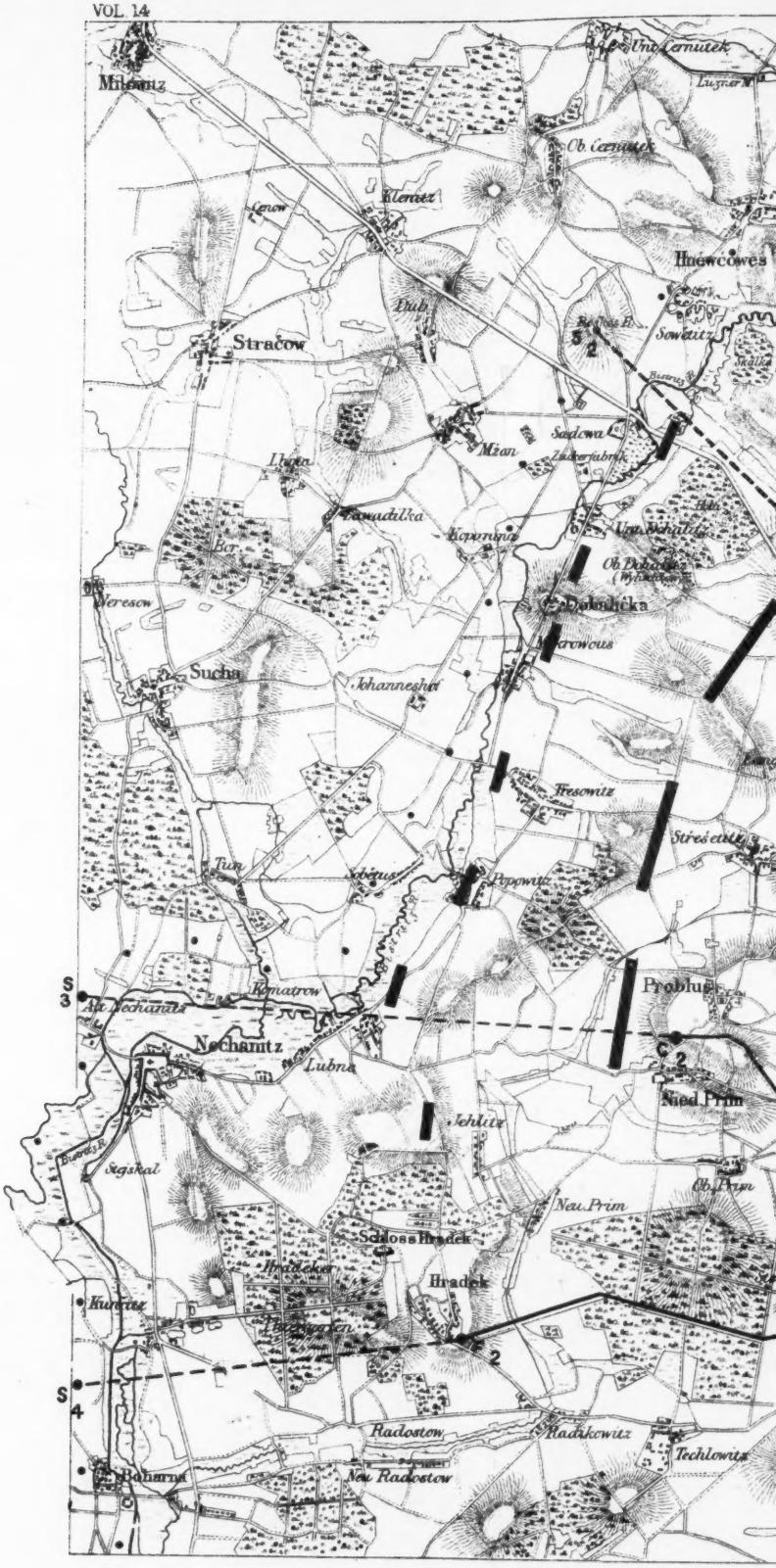
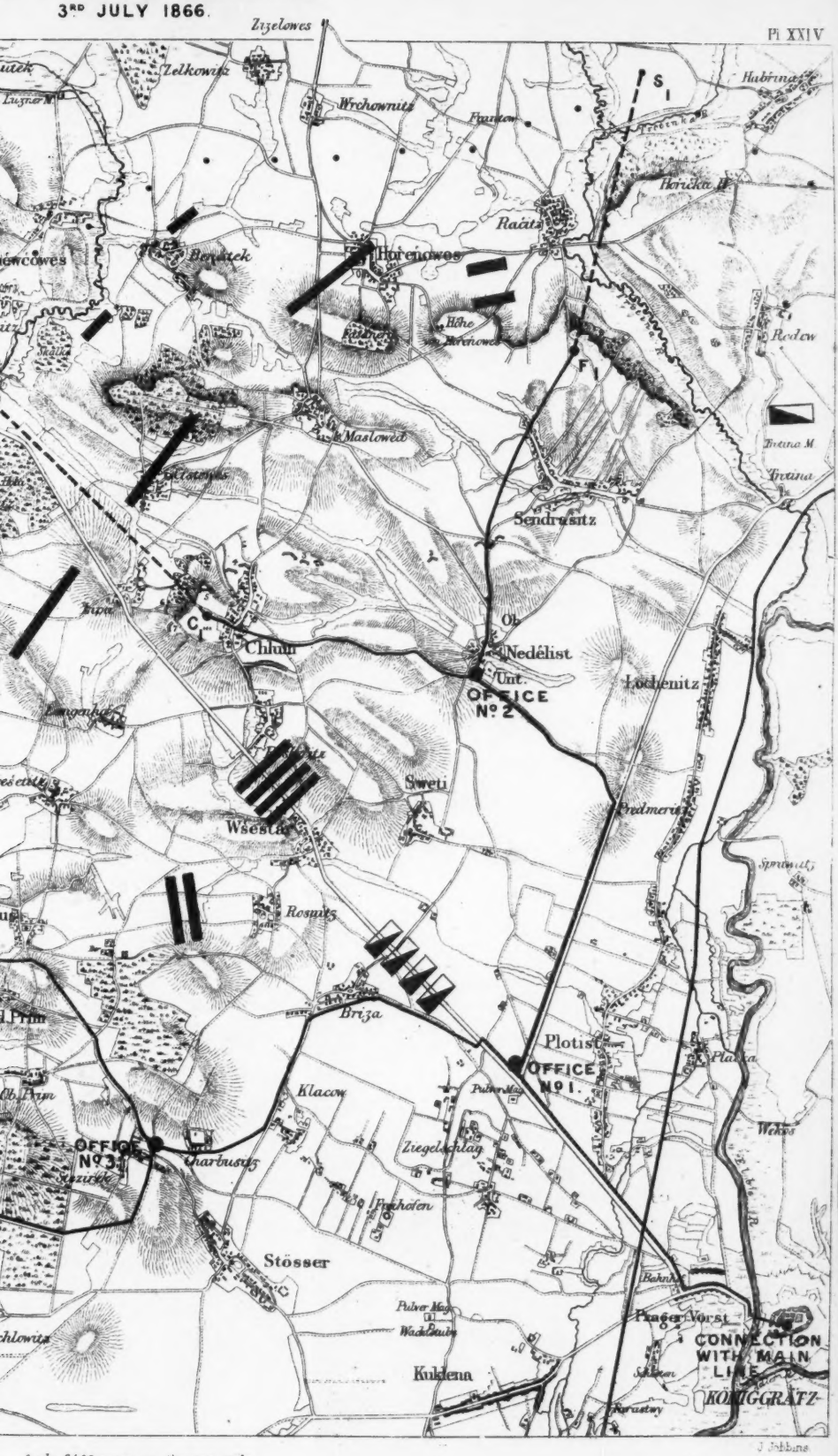


LE-FIELD OF KÖNIGGRÄTZ.
3RD JULY 1866.

Pl. XXIV



IS THAT OCCUPIED BY THE AUSTRIANS AT 6 O'CLOCK A. M.

In conclusion, I would call your attention for a moment to a practical application of the system I propose. On the accompanying diagram (Plate XXIV.) I have sketched out the arrangement of field electric telegraph and signallers, which seems applicable to the ground on which the battle of Königrätz was fought. I would propose to make a connection with the main line at the fortress of Königrätz, and thence to form a field line to the vicinity of Ziegelschlag, where No. 1 Office would be established. From this point No. 2 section would form a line to the right, as far as Nedelist, with branches to Chlum and the hill marked near Sendrasitz, and with visual signallers beyond the Trottina in one direction, and beyond the Bistritz in the other; if possible, a system of signalling would be established, in connection with the latter, as far as the high ground in the vicinity of Milowitz. On the left I would propose, with No. 3 section, to form a line to Stezirek, establishing No. 3 Office at this point, with branches to the hill, on which is placed the village of Prim, and through the wood in the direction of Hradek. From these points I would propose to throw out visual signallers in the direction of Nechanitz and Kunsitz.

It will be remembered that the attack of the first Prussian Army and the Army of the Elbe, the whole under the command of Prince Frederick Charles, was made early in the day, along the line of the Bistritz; that this Army made a steady advance up to a certain point, and that between two and three o'clock in the afternoon they were checked; no material advance was made for a long interval of time, and the position of affairs seemed most critical. This state of matters was finally terminated by the successful attack of the second Army, under the Crown Prince of Prussia, on the right of the Austrian position, and by his penetrating to the village of Chlum, comparatively little resistance having been made to his advance. From this moment the fate of the battle was decided, and victory declared for the Prussians.

As regards the movements of the two Prussian Armies on this occasion, there is no doubt that, had they been in possession of a good system of visual signalling, they would have been able to extend their telegraphic operations so far as to have been able to communicate far more readily along the existing lines of electric telegraph than they did. I see no reason, moreover, why they should not have communicated directly by visual signals, as they were within signalling distance, by noon on the day in question.

As regards the Austrians I think that, with a system of electric telegraph and visual signalling, arranged somewhat as in the accompanying sketch, there is no doubt that much more and earlier information as to the enemy's movements would have been obtained, and it is possible that some insight would have been gained as to his operations in the vicinity of Milowitz. The news of the advance of the second Prussian Army on the right would have been received at an earlier period of the day, and in a more authentic form, and more time would have been given to have made the necessary preparations to resist the attack in that quarter.

In the case of a large force advancing to meet an enemy, and moving along a series of parallel roads, I would suggest the same kind of formation as for an army in position; that is to say, No. 1 section

should form a line in continuation of the semi-permanent line to the base of operations, while Nos. 2 and 3 would connect to the right and left, and form lines to the flank with signallers thrown out as before. Always supposing that the semi-permanent line was completed with sufficient rapidity from the rear, there would be no difficulty in advancing the main line, to keep up with the daily advance of the force by means of No. 1 section, while Nos. 2 and 3 would be required each day to reel up, and, after advancing by parallel roads, to re-establish the branch lines at the next halting place. Manœuvres on this principle were carried out by the French during the summer of 1868, at the camp at Chalons, an advancing force having been followed up, and telegraphic communication established daily between its flanks and centre. No difficulty was experienced in carrying out the plan proposed. A greater quantity of line wire would, however, be required to work such an arrangement effectually, and it could best be done by the employment of two units of equipment, instead of one, as by such an addition of means the work of each unit would be reduced to the dismantling of the line, followed by a march on the first day, and the construction of a line on the second, and so on, on alternate days. This would reduce the work to be performed within reasonable limits. To do all with a single unit would entail enormous exertion, which could not be kept up continuously for any length of time by any single set of men and horses.

From our experience of the speed which has been attained in the construction of a line with the equipment proposed, there is no doubt but that a field electric-telegraph could be formed sufficiently quickly in rear of a force advancing to the actual attack of an enemy on an extensive front, to enable constant and effectual communication to be kept up. For example, at the battle of Königrätz, there would have been no difficulty in carrying one line in rear of the force advancing on the village of Sadowa, while another might have followed up the Prussian right attack, under Herwarth Von Bittenfield, and if the two had been made to converge upon Milowitz, messages could have passed to and fro with speed and facility, and it would no longer have been necessary for those on the left, to guess the probable success of the right attack by the movements or stationary position of the smoke of the firing.

For such a combination it is, of course, not essential that the telegraph should be attached to the main line of communication.

During recent campaigns, very large numbers of men have been manœuvred together in the field, numbers which cover such a space, that the ordinary means of communication, by mounted messengers, can never fulfil the duties of transmission of orders and intelligence with sufficient rapidity; and just as a battalion is most effectually commanded by the voice, and a brigade or division by means of mounted messengers, I believe a force of 100,000 men and upwards would be most effectually commanded by telegraphy and signalling.

In this country we are undoubtedly slow in taking up any new question connected with the art of war; the sort of idea that active operations are a remote contingency, combined with the views of economy

under which the Army Estimates are always drawn up, act prejudicially against the introduction and effectual development of any improvements, and the electric telegraph is no exception to this rule. Almost every European nation, except Great Britain, has now a properly organized field electric telegraph; even the smaller powers, such as Bavaria, Belgium, Denmark, &c., have their properly constituted equipments. We have the most authentic information concerning the Prussian equipment; this consists of six complete units of field telegraph, or in other words 18 travelling offices and 180 miles of line wire, these are in charge of the Engineer Corps at Berlin, and are all ready to take the field at a few days' notice. Great Britain possesses, at this moment, a few experimental carriages and 8 miles of experimental wire at Chatham; and carriages and material for one section of a unit are now being organized at Woolwich: these latter will raise our total by one travelling office and 12 miles of efficient conducting wire, making a total of 20 miles in all. We have no organisation except on paper, and that has not yet been sanctioned by proper authority. If we are ever to work the question out, so as to arrive at a proper conclusion, it is manifest that far greater means must be put at our disposal; and, as a minimum, I would propose one unit of equipment permanently horsed and manned, with two units complete and in store, only requiring horses and men to put them on a war footing.

Since this paper has been written, we have decided to recommend the addition of a light boat to the field telegraph equipment. It is proposed to carry this boat, with one bay of pontoon bridge equipment, on a carriage drawn by four horses. It would be used to carry the line across rivers; where a road crossed at a ford, it would not be desirable to lay an insulated line through the ford, as it would be likely to be injured by the traffic; it must be laid some little distance away in order to keep it secure. Similarly, it would not be desirable to lay it very close to a pontoon bridge, as it would get mixed up with the anchors and other tackle: in this case, therefore, it must be placed some little distance away. In these and similar positions, the boat would be useful. The Prussians include a small boat as a part of their field telegraph-equipment. One of the ordinary boats of the pontoon equipment would be too heavy and require too many men to manage it, and would not, therefore, be applicable for the service required. A much smaller and lighter boat is, therefore, about to be designed for this purpose.

DETAIL OF OFFICERS, MEN, AND HORSES.

		Telegraphers.	Signallers, Constructional and Troop Staff.	Total Officers and Men.	Horses.	Remarks.
Officers	Captain Commanding Troop	1	..	1	2	
	Lieutenants	3	..	3	6	
	Assistant Surgeon	..	1	1	2	
	Veterinary Surgeon	..	1	1	2	
	Total			6	12	
	Officers' bât horses				6	
					18	
N.-C. Officers, Artificers and Men.	Troop Sergeant Major	1	..	1	1	
	Troop Quartermaster Sergeant	..	1	1	1	
	Pay Sergeant	..	1	1	1	
	Sergeants Mounted	3	3	6	6	
	Sergeants Dismounted	3	..	3		
	Corporals Mounted	..	3	3	3	
	Corporals Dismounted	6	..	6		
	Second Corporals Mounted	..	3	3	3	
	Second Corporals Dismounted	6	..	6		
	Lance Corporals Mounted	..	3	3	3	
	Lance Corporals Dismounted	6	..	6		
	Farrier Sergeant	..	1	1	1	
	Corporal artificers	..	2	2		
	Shoeing smiths	..	6	6	3	
	Collar makers	..	3	3		
	Wheelers	..	3	3		
	Carpenters	..	3	3		
	Trumpeters	..	3	3	3	
	Sappers	..	90	90		
	Exclusive of Lance Corporals Drivers	..	75	75	100	
	Exclusive of Lance Corporals Signallers	..	20	20	20	
	Total	25	220	245	145	

The CHAIRMAN: I have great pleasure in moving a vote of thanks to Captain Stotherd for the instructive and interesting paper just read. I quite agree with the closing remarks of the lecturer, as to the desirability of extending the use of telegraphy and signalling in the army, and so securing the rapid and accurate transmission of messages and orders. It is most desirable to do this in the time of peace, so as to be prepared to use the system in perfection in the event of war. The great advantage of military telegraphy has been fully exemplified in the late battles between Austria and Prussia, when the General in

command of the Prussian Army made free use of the telegraph, and no doubt owed his easy victories in no small degree to its aid. No one can deny that of two opposing armies in the field, the one with the best means of collecting information and conveying it accurately and rapidly from point to point, will be much the stronger in fighting power. The question of cost, therefore, should not arise, for the expense of supplying the telegraph apparatus and training the men, will be saved over and over again. The advantages of having a well-organized system of Telegraphing and Signalling for the British Army, can not be too often, or too earnestly, insisted on.

LECTURE.

Friday, May 27th, 1870.

SIR T. GALBRAITH LOGAN, K.C.B., M.D., Director-General Army Medical Department, in the Chair.

MILITARY HYGIENE.

By F. DE CHAUMONT, Esq., M.D., Army Medical School, Netley.

THE subject which I have the honour to bring to your notice this day is one of so comprehensive a character, that I might well hesitate before attempting its exposition in a single lecture. I hope, however, to be able to lay before you a few points of interest selected from the wide range of inquiry which the study of hygiene embraces. Let me say a few words in the first place as to the nature and character of the study. Hygiene (or *medical police* as it used to be called in this country) is that branch of study which treats of the laws of health. This is its widest application, and we hesitate to call it a science, chiefly because it is based upon many other divisions of knowledge which are themselves still imperfect; it is, in fact, as yet merely an art by which we apply to the preservation of health the points of knowledge derived from many sources. Its highest aim being to produce the "mens sana in corpore sano," it is obvious that nothing which bears directly or indirectly upon health is excluded from it, which is simply tantamount to saying that it includes everything cognisable by man. But, the causes that act and react upon the human economy being practically infinite, to integrate them so as to produce a definite expression, which shall be presented as a perfect science, is hopeless. All we can hope to do is to approach as nearly as possible to the limit which can never by any possibility be reached. But within this vast circle there are others to which we may profitably confine our attention for the time, and within which we may direct our inquiries to those points in the material well-being of man, which are more immediately under our control. Hygiene, then, is the art of preserving health by removing all that is injurious to life, and supplying all that is needful for life. It aims at rendering life vigorous, painless, free from disease and prolonged, so that a truly hygienic being would cease to exist purely from natural decay. Whether or not it would be possible to lengthen life materially or indefinitely, is a speculation which has often suggested itself, but which we are at present too ignorant to consider.

Hygiene, although but recently placed on a scientific basis, is by no means a new object of human study; it is at least as old as history itself. The ceremonial law of Moses was as perfect a system as the knowledge of the time could produce. Hippocrates embodied in his works the

precepts of many older and now forgotten writers. The life of the Greeks was eminently hygienic. The vast systems of baths built by the Romans, their system of sewers, their mode of water supply and many of their domestic arrangements, proved how far they understood the art of health in peace, while the rules of Vegetius may be even now profitably studied as a guide in time of war. It was reserved for the fanatical asceticism of the middle ages to outrage every law of health, to impose upon the world the idea of the contemptibility of caring for the body, and in fact to accomplish what may be fitly termed the apotheosis of filth! What can we think of a community in which the cleanliness of the body was regarded as a pollution of the soul, and the cynosure of all devout eyes was such a hideous mass of filthy insanity as St. Simeon Stylites! The outcome of all this was, that epidemics of a virulence unknown to classic times devastated Europe, and it was only with the revival of letters, when the intellect of Europe began to shake off the shackles of tradition and priestly domination, that a return was made to the paths that had been so long forsaken. Even now, with all our boasted science, we are only going back in a measure to the principles already firmly established fifteen centuries ago, but the practice of which disappeared with the fall of the Western Empire. We are even now in some practical points behind that age, and it will be long before we make up for the death-like sleep of a thousand years, during which, as Michelet says, not one in Europe ever took a bath!

Hygiene in its detailed application includes the following points:—the supply of *air*, *water*, *food*, *clothing*, *shelter* and *exercise*, and the removal of *waste* and *effete* products arising from what source soever. Deficiency in the supply of the above requisites weakens the human frame and induces constitutional diseases; neglect in the removal of waste products favours the development of actual poisons which give rise to epidemic and zymotic diseases. This is of course a general statement requiring modification according to individual circumstances. The relative importance of each cause advances, both as regards rapidity and intensity of effect. Thus, whenever a sudden invasion of disease takes place, affecting a large proportion of a community at the same time, such as an attack of diarrhœa, it is generally due to some poison introduced through the water-supply, and it is seldom that inquiry fails to trace it to this source. On the other hand, the most fruitful source of disease, although less immediately recognisable in its operation, is impure air from defective ventilation. While to bad water we owe in a large measure the propagation of such diseases as diarrhœa, dysentery, cholera, typhoid fever and the like; to bad air we owe pulmonary consumption, pneumonia, typhus fever, scrofulous disorders, and many others, some apparently *generated* by the products of respiration, others unquestionably *favoured* and propagated by a want of proper interchange of air. The importance of this question with reference to the health of the soldier is so great that I propose to ask your attention for a little to the subject. The necessity for good ventilation and the proper methods of obtaining it have been very fully discussed of late years, and it may be considered as pretty

generally admitted that it is a question of the very gravest moment. Death-rate has been shown to increase in a pretty regular ratio with the increase of inhabitants to the square mile, and, putting exceptional causes aside, the most virulent disease and the greatest mortality are to be found in the most crowded localities. Of course among the civil population, poverty and starvation have to be taken into consideration, for among them crowding necessarily means poverty, want of means compelling them to huddle together to save the crushing expenses of house-rent and fuel. Among soldiers, however, it is possible to eliminate these disturbing causes to a certain extent, for the men are selected lives, are, on the whole, well fed and clothed, and are not more exposed in time of peace to vicissitudes of temperature than the civil population. Yet, in spite of these advantages, and putting aside all other deleterious influences, the researches of the Royal Commission of 1857 showed that the death-rate of the soldier at home was up to that time *twice* that of the civil population of the same ages. To what was the death-rate chiefly owing? To two diseases mainly, viz., typhoid fever and pulmonary consumption (or a destructive lung-disease). Now the former is almost entirely due to bad conservancy, that is, neglect in the removal of excreta, and the latter, by far the more destructive, to bad air, caused by bad barrack accommodation and deficiency of the supply of fresh air. The whole question was carefully investigated by the Commissioners, and the conclusion arrived at was, that to *bad air* the greater part of the Army mortality in time of peace was due. This was a conclusion for which the public generally was hardly prepared, but its truth was borne out by other investigations, for the same results arising from similar conditions were found to obtain in Continental Armies as well as in our own. Nay, further than this, similar influences were also found producing analogous effects among the lower animals, horses in badly ventilated stables, dogs in confined kennels, and even monkeys in ill-constructed dwellings were found to fall rapid victims to destructive lung disease, having in many cases characters similar to that which carries off so many of our soldiers. Since that time a very great change has taken place, increased accommodation and better means of ventilation having been provided in accordance with the recommendations of the Barrack Commission assembled in the following year, 1858. Imperfectly as these recommendations have been as yet carried out, the results are most encouraging, for the death-rate of the soldier now is reduced to *one-half* of what it was before the Crimean War, a most cheering and gratifying fact, even if we admit that it is not entirely due to this one set of changes. For although numerous causes have undoubtedly combined to bring about this result, yet enough of it may be traced to direct hygienic improvements to encourage us to make every effort to promote further advances in this direction.

I have alluded to the recommendations of the Barrack Commission as having been imperfectly carried out; let me now explain what I mean. The recommendations were that each soldier should have 600 cubic feet of space in barracks, and 1,200 in hospitals, and that the air of this space should be changed *twice* in the hour, thus giving

1,200 cubic feet per head per hour, in barracks, and 2,400 in hospitals. To accomplish this, improved methods of ventilation were recommended and in some cases supplied. I have now made detailed experimental inquiries in a good many barracks and hospitals, and I take this opportunity of laying before you very briefly the results, which may be seen by a glance at the accompanying table. From it you will observe that the rate of change of air is considerably below *twice* in the hour in the majority of instances, so that to provide even the moderate amount of air proposed by the Barrack Commissioners, a much larger initial cubic space would be requisite, or in other words the number of occupants ought to be reduced :—

Place. Barracks.	No. of times air changed per hour.	Cubic space required per man to give the proposed amount of air, viz., 1,200 in barracks, and 2,400 in hospitals.	Average actual amount supplied, taking the initial space at 600 per man.
(*a*) Netley ..... (one room)	3·30	365	1980
Hilsea..... (brick huts)	3.25	370	1950
Fort Brockhurst	3·00	400	1800
Aldershot..... (ventilated on principles of Barrack Commission)	2·35	520	1410
Chelsea..... (no outlet shaft)	2·20	550	1320
.....	.....	.....	.....
Hilsea..... (room over stable)	1·74	690	1044
(*a*) Chatham	1·70	710	1020
(*a*) Netley.....	1·65	730	990
Fort Elson..... (no shaft)	1·30	925	780
Gosport	1·20	1000	720
Tower.....	1·20	1000	720
Anglesey	1·20	1000	720
(*a*) Milton Barracks, Gravesend.....	1·18	1010	708
Aldershot ..... (original rooms in permanent barracks)	1·16	1020	696
(*a*) Chatham.....	0·80	1500	480
(*a*) Netley.....	0·72	1670	432

Hospitals.	No. of times air changed per hour.	Cubic space required to give the proposed amount of air, viz., 2,400 feet per hour.	Average actual amount supplied taking the initial space at 1,200 cubic feet.
Hilsea.....	3·12	770	3744
Herbert ..... (Woolwich)	2·20	1095	2640
.....	.....	.....	.....
Portsmouth* ... (Garrison Hospital)	1·10	2180	1320*
(*a*) Chatham ..... (Fort Pitt)	0·90	2660	1080
(*a*) Netley.....	0·90	2660	1080
(*a*) Chatham ..... (Fort Pitt)	0·55	4350	660
(*a*) Netley.....	0·55	4350	660

From these numbers we see that the results contemplated by the Commission have been obtained in only *five* barracks and *two* hospitals, viz., those above the dotted lines in each table. The experiments from which the calculations have been made were carried out by myself, except in those cases marked (*a*).

I think it will be admitted, on considering these results, that a good deal still remains to be done, even to arrive at the moderate degree of ventilation proposed by the Commission. I am, however, far from admitting that even this would be sufficient to ensure perfectly hygienic conditions, but it would still be a great advance upon the actual state of things. It cannot be too frequently insisted upon, that there is a practical limit to the number of times that air can be changed *without draughts* by ordinary appliances, and that therefore there is a limit to the number of occupants in an air space, which cannot be exceeded without serious danger to health, and even life. Theoretically speaking, the cubic space a man occupies is immaterial, *provided* always that the power of changing the air is unlimited; but it is perfectly plain that, if we cannot change the air more than twice in the hour, four men in that air space will only get each one-half as much as two. Therefore in placing a limit to the cubic space allotted, the possibility of changing the air sufficiently often, ought to be one main element of the calculation. The whole question is one of expenditure, for of course increased cubic space means more extended barrack accommodation, and greater outlay, both for warming and other things. On the other hand, special appliances for ventilation are also costly, and few have as yet given much satisfaction. I do not doubt, however, that we shall arrive ultimately at some means of combining economy with efficiency in this

* In this case the initial cubic space was only 800 feet, so that the air supplied was only 895 cubic feet per hour. Had the wards been full the space would have been only 680, and the amount of air 748 cubic feet only.

matter, and securing to the soldier an habitation which shall be really a shelter, and not a manufactory of disease.

I have dwelt thus particularly upon the question of ventilation as being the most important with regard to the soldier's health in time of peace; it is the most fruitful source of mortality, and the most constantly operating cause of disease. Of course it is not actually of less importance in time of war, but it is relatively less so on account of the presence of so many other causes which unite to attack the health of the soldier. I propose now in the remainder of this lecture to refer to some of the more important of these.

In the first place, the actual amount of physical exertion to be gone through is generally greater in time of war. Can we do anything in time of peace to prepare the soldier for this? For we must never forget that the trade of the soldier is war, and that, but for the existence or the possibility of war, he would cease to have a *raison d'être*. Many soldiers pass through their whole career without ever encountering actual warfare, but their whole training is to render them fit for a possible contingency, which, it is true, may never arise, but which the soldier must ever be prepared for. The amount of physical exertion which a man can undergo depends upon many things, the way he is fed, the way he is clothed, the climate he is in, and innumerable other causes which influence his health, morally and physically. Our first care, then, should be to preserve his health at the highest standard in time of peace by supplying an ample and wholesome diet, appropriate clothing, well ventilated barracks, &c. But there still remains the question of training and exercise. How far should these be carried in peace, with a view to the severer trials of war? It is the opinion of some that the amount of physical labour in peace should be strained to the utmost, even beyond what is likely to be required in war, so that when the latter comes it may be found more easy of endurance. It was on something like this principle that the Romans acted, giving their men so much labour in peace time, that they hailed the approach of war with delight, as a season of rest and variety. This was, perhaps, good policy in a nation eminently aggressive, who loved war better than peace, and claimed to make it an object of attraction to its citizens. But the condition of matters is changed at the present day; we keep an army as a necessity, but a necessity which we regret. We do not desire to instil a longing for war into our citizens; we merely wish to keep the instrument of defence in the highest state of efficiency, ready to be used on the instant when the hour of war does come. Under such circumstances it seems to me that it would be an eminent mistake to train the physique of the soldier too far; full and constant occupation he ought to have, but considerably within the limits of extreme physical effort. It stands to reason that a cord perpetually stretched will lose its elasticity, and probably give way when the important moment arrives. I think this is now pretty generally understood, and it receives an instructive illustration from the practice of professional singers, who by exercising their voices within a moderate compass, find that they can the more easily make an extreme effort when the occasion calls for one.

It is not, however, only in the preparation in time of peace that the power for physical effort depends. Man is a machine, just as much as a steam-engine or a galvanic battery; the amount of force he gives out is exactly proportioned to the amount of convertible material he takes in. We can calculate to a grain the force obtainable from the burning of a certain amount of coal, or the oxidising of a certain amount of zinc, and similarly (though, as yet, somewhat less perfectly) we can calculate the amount of force obtainable from the amount and quality of food supplied to the human economy. And this question of food is at the bottom of all the difficulties and disasters of a campaign. It used, in the great war in the beginning of this century, to be a favourite joke of the French soldiers against the English to say that you should never ask an Englishman if he has *fought* well, but ask if he has *dined* well, and then you may be sure he has fought well. Like many a word spoken in jest, there is deep truth contained in this, of whatever nationality the soldier may be. There can be no doubt that armies have performed prodigies of valour under circumstances of great privation, but we may be sure of this, that as Providence has been said to be on the side of the largest battalions, so it will also be on the side of the best fed battalions. This is well put in the report of an experienced French Officer, Colonel Comte de Clonard, commanding the 81st regiment of the Line. He says: "Devant l'ennemi, "il suffit de payer un instant de sa personne; l'exemple des chefs "entraîne, électrise: le drapeau fait le reste. Hors de là, c'est autre "chose, car on ne se bat pas toujours. Dans les marches et les camps, "au milieu de fatigues et d'épreuves souvent nécessaires et glorieuses, "c'est par une bonne ou une mauvaise administration qu'on prépare "les hommes à vaincre ou qu'on les perd. Il faut donc savoir faire "*durer* le soldat, mais c'est à la condition d'en avoir soin, de lui donner "une alimentation suffisamment réparatrice et parfois *tonique* et *variée;* "il sera dès lors en état de braver impunément toutes les autres "misères de la guerre." (Chenu, Campagne d'Italie.) Nothing, indeed, lays a man more open to an attack of disease than encountering it insufficiently nourished. On this principle medical men and the attendants on the sick never, as a rule, visit a contagious case on an empty stomach, if it is possible to prevent it. Now, in providing for the diet of the soldier in war, two important points have to be borne in mind:—

1st. To provide a diet that shall furnish sufficient force for the work required of him; that is, to make the food proportionate to the exercise.

2nd. To provide a diet of sufficient variety to prevent the occurrence of scurvy.

The importance of the first point has been more or less recognized at different times, and it would appear that Hippocrates (the great father of medicine) had very clear notions on this point. It was, however, possible to come to a definite conclusion on the subject only after the sciences of chemistry and natural philosophy had been brought to a high stage of advancement, and after the theory of the conservation of force had been recognized. So long as heat, light.

electricity, chemical action, vital force, &c., &c., were considered separate entities, it was hardly possible to treat the question scientifically; but now that all these are admitted to be mere forms of force, or, perhaps more correctly, to be universally and perpetually convertible into each other, equivalent for equivalent, we are enabled to approach the inquiry with more confidence, and to place our conclusions on a more strictly scientific basis. The question is still obscure, but researches are gradually throwing more and more light upon it. After Liebig had pointed out the two important divisions into which food may be separated, the nitrogenous or plastic, and the carboniferous or combustible, the idea long held almost undisputed sway that the former went to repair the tissues whose waste supplied muscular energy, and that the latter were burned off in the lungs and supplied the necessary animal heat. It was therefore supposed that a certain amount of nitrogenous matter and a certain amount of carboniferous matter being given, life could be sustained in efficiency. Further inquiry showed that these views were only partially true, for it was found that all nitrogenous substances were not equally assimilable, some, notably gelatine, although largely present in the bodies of animals, not being capable of being substituted for albumen or fibrin, and not being nutritious at all except under peculiar circumstances. It was also ascertained that the carboniferous aliments required subdivision into two classes, the fats and the carbo-hydrates (the latter including the starches and sugars), which two classes could reciprocally replace each other in certain proportions, but not entirely. A certain amount of mineral matter in the form of salts, either existing in the articles of diet or added in bulk, was also found to be absolutely essential for the preservation of health. Up to this point, the results ascertained were the following:—

1. Living animals absolutely require nitrogenous matter in their diet.
2. The nitrogenous matter may be animal or vegetable.
3. Most animals require a certain amount of fat.
4. Many animals require, in addition, a certain amount of starch or sugar.
5. All animals require a certain amount of salts.

A second series of conclusions are the following:—

1. Some animals (such as dogs and rats) can live on a purely meat diet.
2. Many animals (carnivora) can live upon meat and fat.
3. Many animals (herbivora) live upon vegetable products only (including nitrogenous matter and starch chiefly, with a small quantity of fat.)

4*a*. *Man* can live on vegetable products only, provided they contain nitrogenous matters, starch, and fat in due proportion.

b. *Man* cannot live and maintain health upon meat alone, or upon meat and fat alone; he requires the addition of starch.

These being the main conclusions, how were they interpreted? It was considered that the carbo-hydrates—starch and sugar—were chiefly employed in giving out the animal heat; that the fat acted

partly in this way, and partly was stored up in the system against contingencies; that the nitrogenous went to repair the wasted tissue, chiefly the muscles, and that it was the wasting of these that supplied the physical force manifested by the individual. These principles are still defended by Baron von Liebig, Lyon Playfair, and other distinguished men; but, on the other hand, a large number of experiments have been made by men of great scientific acquirements, such as Pettenkofer and Voit, Fick and Wislicenus, Lawes and Gilbert, Haughton, Parkes, and others, which seem to point the other way. If the waste of the muscles were the direct or sole cause of force, then, in cases of excessive exertion, some increased elimination of nitrogenous matter would be observable; but the majority of the experiments seem to show that this is not the case, so much so, that in some cases the elimination seems to be lessened, apparently from the increased exercise causing retention of the nitrogen to provide for the increase in size of the muscles, which usually follows. On the other hand, increased exertion is attended with increased elimination of carbonic acid and vapour of water, showing a marked excess in the combustion of the carboniferous matter in the system. The inference suggested by these observations is, that the body is, in the main, like a steam-engine, and that the force evolved is due to the combustion of the fuel supplied. Therefore, it is to the carboniferous elements of food that the energy is in the main due, and not entirely, as was supposed, to the nitrogenous. The body, however, differs materially from an ordinary machine, for the latter wears away without power of reparation, all we can do being to diminish as much as possible the effects of friction. The former, however, has the power of perpetually assimilating fresh material, and continually repairing the waste as it occurs. It is obvious, however, that in the latter case *some* force must be evolved, just as there is force (in the form of heat chiefly) evolved in the friction of the wheels of a machine, and it is important, therefore, to inquire what becomes of this force, how it is employed, or how it is neutralized. It would seem probable that it is partly employed in the digestion and assimilation of the nitrogenous matters, and partly in the elimination of the waste products. Now, as the balance seems to be kept pretty strictly between the amount of nitrogen ingested and egested in a person well fed and in good health, it is probable that the amount of nitrogenous food necessary for the highest efficiency is that which shall preserve this balance most perfectly under varying circumstances. If the amount of nitrogen be diminished below the proper standard, weakening is produced, with emaciation, the result of more rapid destruction than can be repaired by the fresh material supplied. But if at the same time the amount of physical exertion is proportionately diminished, this lessening of the nitrogen is balanced to a certain extent, and can be endured within certain limits, whilst a comparatively small quantity is required for actual subsistence in a state of complete rest. If, however, exercise be continued, then, as it appears that the muscles while in action appropriate nitrogen, this nitrogen must either be supplied by the food, or be drawn from some other part of the body. In short, in the absence

of a proper supply of food, the active muscles feed upon those parts which are less actively employed, or which are less capable of resisting the depredation. In this way, the heart is apt to suffer; it is itself in constant action, and therefore requires a large supply of nitrogen, which supply is diminished if the voluntary muscles are thrown severely into play without sufficient provision being made by increased food. It is thus evident that an increase of nitrogen is necessary in direct proportion to the increase of work; but the energy necessary for the work is certainly not wholly, nor even mainly, derived from the nitrogenous matter. It is quite true that the body is able to use nitrogenous matter in this way, but generally this is on compulsion, as it were, and when no other material has been supplied; but the loss of force under these circumstances is so great that the system soon becomes exhausted. It is, therefore, necessary to supply material which is easily oxidised, and capable of rapidly yielding up its potential energy under the influence of the changes wrought upon it in the lungs and circulation. This material is supplied in the fat and carbo-hydrates of which I have already spoken. Weight for weight, the fat has about 2½ times the potential energy of the carbo-hydrates, but it is doubtful if it could be used alone in their stead. In the Arctic regions it appears to be capable of being used in this way to a very great extent; but in temperate and tropical climates it does not appear capable of entirely replacing starch. A practical proof of this was given me by an Officer who served in the Cape, and who told me that on one occasion he formed one of a party of men who for three weeks had nothing but mutton (with, of course, the usual amount of fat) and water. They managed to march on this diet, but their strength gradually gave way, and at the end of the time they were barely able to stand. On the other hand, it is doubtful whether a diet composed of fat-free meat, starch, and water, could support life in a state of efficient health. I am not aware of any satisfactory experiments on this point. One difficulty attending such experiments would be that there are few natural starches which are not mixed with other constituents. All the cereals, for instance, contain both nitrogenous and fatty matters. Potatoes and rice probably contain least fat of the natural starchy matters generally obtainable. It would seem, then, on the whole, that we cannot completely replace either starch or fat, and that a considerable quantity of these substances is necessary for health. Further, as the greatest part of the energy necessary for work is due to them, they must be materially increased whenever more work is demanded.

There still remains another class of substances which are essential to health, this is the *salts*, including the sodium chloride chiefly, the potassium chloride, calcium and magnesium phosphates, &c. All these, except the first, are taken entirely in the food, which requires to be sufficiently rich in them to be thoroughly nutritious. The sodium chloride is also present largely in the food, but the requirements of the body necessitate in addition a considerable quantity to be taken in bulk,—and it may be a question whether some of the others might not

also be taken in the same way with advantage. The use of the salts, apart from those such as the calcium and magnesium phosphates which enter into the composition of the tissues, is rather obscure; but one use can be pretty clearly shown, viz., that they materially assist in the oxidation of matters, whether effete or otherwise, and therefore play an important part in the animal economy. Wherever, then, increased energy is demanded, calling for, of course, increased oxidation, a considerable increase of salts must accompany the additional food. Part of this will of course be supplied in the food itself, whilst part must be added in bulk, chiefly the sodium chloride, but perhaps also some of the others, as the potassium chloride, &c.

The point now to be considered is: How much food ought to be supplied? To answer this we must refer to some of the recent experiments which have been made to calculate out the potential energy obtainable from different kinds of food. This is generally stated as so many foot-tons, that is, as equal to so many tons raised through one foot. There are various ways of expressing it, but we may adopt this one as being very generally used and easily understood. It being possible, then, to calculate how much energy is obtainable from each substance, what we require to know, in order to apportion diet to exercise, is the amount of force required. Now, we can calculate pretty correctly the amount of work done by an individual, and we can also (from Professor Haughton's ingenious researches) ascertain the force expended by the involuntary work of the body, such as the heart's action, &c.,—but there still remains a quantity more difficult to estimate, viz., that required for the evolution of the animal heat and other processes in the system. We can, however, arrive at this experimentally by finding the amount of food which will keep a man alive at rest, considering this as the minimum, and also the amount which will keep him in health at average work. To this latter we can then add proportionately for excessive work. The subsistence diet for a man at rest, calculated from Frankland's figures (Parkes's Hygiene, p. 170), is the following:—

Nitrogen.....	138 grains	} Equal in potential	
Carbon	3,030 „	} energy to about	
Salts	219 „	} 2,330 foot-tons.	

Now, as the work of the heart, &c., has been calculated at about 260 foot-tons, there would remain 2,070 as absolutely required for the animal heat and other processes at the lowest calculation. But this must be materially increased with every increase of exertion, for the heart works more rapidly, the circulation moves quicker, the chemical changes go on at a greater rate, and more animal heat is wasted. Accordingly we find that the standard average diet for a man at work is as follows:—

Nitrogen.....	316·5 grains	} Equal to about 3,833	
Carbon	4862·0 „	} foot-tons of poten-	
Salts	461·0 „	} tial energy.	

If now we consider that a man on this diet is doing a good day's work,

equal to 300 foot-tons, and add to this 260 for the internal mechanical work, we have remaining for the animal heat, &c., 3,273, or an increase over the subsistence-diet of 1,200. It would therefore seem as if for every foot-ton of external work, we ought to add in addition about four more for the internal processes, or we must supply five times the potential energy as food that we expect to obtain as labour. Even this calculation, however, is short of the mark, for we find that the amount increases at a greater rate as the work advances. For a man doing laborious work, that is, equal to about 450 tons per diem, the following is the mean calculated diet:—

Nitrogen.....	450	grains	Equal in potential energy to about 4,784 foot-tons.
Carbon	6,242	„	
Salts	580	„	

Or an increase of 1,049 potential tons to provide for the additional 150 tons of productive labour; here the increase is seven times instead of five,—so that the addition required as work increases is almost in a geometrical instead of an arithmetical ratio. Let us now examine the diets issued to soldiers, and compare them with the above standards. The ordinary diet of the English soldier at home is the following (as calculated by Dr. Parkes):—

Nitrogen.....	266	grains	Equal in potential energy to about 3,640 foot-tons.
Carbon	4,718	„	
Salts	354	„	

In this diet the carbon is about sufficient, but the nitrogen is much too small, and the salts are also deficient in quantity. It is right to mention that Dr. Playfair has calculated out the diet as rather more nutritious, bringing up the energy to 3,848·5 tons. I cannot help thinking, however, that there has been some difference in the mode of estimate, and that Dr. Playfair has calculated the ration of meat as *without* bone, whereas it is really reckoned including bone. Adopting, then, Dr. Parkes's calculation, we find that the above diet is much below the average of a working-man's standard, and that it is a diet in short on which we could not demand more than a very moderate day's work, say 150 to 200 tons. It is true that in time of peace the soldier's duties are not so arduous as those of the majority of labourers, but still the above diet is insufficient to keep him as he ought to be kept, in the highest state of health. Were the meat ration to be increased, as was at one time proposed, from 12 to 16 oz., including bone, the diet would then stand thus—

Nitrogen.....	303	grains	Equal in potential energy to about 3,838 foot-tons.
Carbon	4,948	„	
Salts	379	„	

The salts would still be rather low, but the diet on the whole would be a fair one, sufficient for average work of from 250 to 300 tons—not by any means an excessive estimate, seeing that a march of ten miles in heavy marching order is alone equal to 250 tons. When, however, troops come into the field much more is demanded of them, and the

diet ought to be arranged accordingly. We have to bear in mind that not only is there more actual work, more waste of tissue, bodily and mental, but that also the food is in many cases not so good in quality, and, therefore, incapable of yielding the same amount of potential energy. A war-diet ought to provide for a minimum work of 350 to 400 tons, and be capable of being increased at the shortest notice to 500 tons or more, as circumstances call for it. Such a state of things would be met by a diet of the following proportions:—

Nitrogen.....	350	grains	Equal in potential energy to about 4,280 foot-tons.
Carbon	5,500	,,	
Salts	450	,,	

To be increased as circumstances demanded to—

Nitrogen.....	450	grains	Equal in potential energy to about 5,000 foot-tons.
Carbon	6,500	,,	
Salts	500	,,	

Now, in scarcely any instance has a war-ration reached this amount. In the Crimea, in our own Army the ration *nominally* came to about 272 to 290 grs. of nitrogen, about 4,400 to 5,000 of carbon, and about 280 to 320 of salts; but it was only late in the campaign that this ration was really issued. It will be but too well remembered by those who passed through the first year of that memorable war, how miserably deficient the ration really was. Our own errors and misfortunes at that time have, however, been fully criticised and exposed, and I should fear to weary you unnecessarily by going over the same ground again. But it is only comparatively recently that a full account of the experiences of our allies has been published in the two great works of Dr. Chenu, viz., the Reports on the Crimean and Italian Wars, the latter work containing in an appendix many documents referring to the former campaign. From this we find that the ration in February, 1856, consisted of the following:—

Bread.. ..	750	grammes	= 26·50	ounces	Total 41·04 ounces.
Meat.. ..	300	,,	= 10·60	,,	
Rice	60	,,	= 2·12	,,	
Sugar ..	20	,,	= ·70	,,	
Coffee ..	16	,,	= ·56	,,	
Salt	16	,,	= ·56	,,	

Fresh meat was distributed four times in ten days, salt meat (250 grammes = 8·8 ounces) on three days, and preserved meat on three days. If biscuit was issued, 550 grammes (= 19·4 ounces) were given. An *occasional* extra ration was issued, according to circumstances, of—

Biscuit ..	100	grammes	= 3·6	ounces.
Wine ..	$\frac{1}{4}$	litre	= 8·8	,, three times a week.
Brandy ..	$\frac{1}{16}$	,,	= 2·2	,, four times a week.

This was equivalent to the following :—

Nitrogen.. ..	263 grains	} Equal in potential energy	
Carbon	4327 „		to about 3,348 foot-
Salts	472 „	}	tons.

The additional ration when issued would add about 78 grains of nitrogen, 660 of carbon, and 26·6 of salts, and of potential energy about 400 tons. It is obvious from what has gone before that such a diet was totally inadequate to support men on active service. It is true that additional rations might be issued "à titre de remboursement," but the pay of the French soldier is very small, and he could hardly have added much to his diet in that way. Besides this, I am afraid that even this insufficient diet existed chiefly on paper, for from the information I could myself gather in conversing with French Officers, it would seem that fresh meat was not as a rule distributed anything like so often as four times in ten days. The insufficiency of this diet was fully recognized and protested against by the Medical Officers, whose remonstrances were, unfortunately, too often disregarded.

In the rations of the Prussian, Austrian, and Russian Armies, the same error seems to prevail as in the French and English, viz., a deficiency of nitrogen and a too great preponderance of starchy matters, a diet, in short, insufficient to preserve men in health during active work.

I have gone in some detail into the *quantity* of food, let me now say a few words as to the *quality* and *kind* of food required. If it be necessary to supply a sufficient amount of food to yield energy adequate for the work required, it is not less essential that the food should be properly proportioned and sufficiently varied. An apparently sufficient amount of energy would be obtained by *calculation* from a diet consisting of pure starch and pure albumen, but such a diet would be practically useless, for it could not long sustain life. There are four essential divisions into which the food requires to be separated, viz., albuminates or nitrogenous substances, fats, starchy or saccharine substances, and salts, and these ought to be in something of the following ratio :—

Albuminates	10
Fats	6
Starches (or carbo-hydrates).. ..	30
Salts	2

These are taken in their proportions when thoroughly dried, all the water being completely driven off. Now in the soldier's diet generally there are the following fundamental errors :—

The albuminates are *deficient.*
The fats are *very deficient.*
The starches are *somewhat in excess.*
The salts are *rather deficient.*

Another important error (now somewhat rectified) is the great same-

ness of the diet. Monotony of diet soon causes the food to pall, the appetite is diminished, and the health suffers. The great enemy that armies have to contend with is scurvy; but for the scorbutic taint it would be comparatively easy to deal with the other causes of disease. Even cholera would lose half its terrors in presence of a thoroughly well-fed body of men. We are still very much in the dark as to what the nature of scurvy is, but we know a good deal empirically of the ways in which it is induced; the following have been ascertained:—

Scurvy may be induced	*May be cured by the use of*
By deficiency of fresh vegetables.	Fresh vegetables, lime-juice, vinegar, salts of vegetable acids, increased nitrogenous food, variety of diet.
,, of nitrogenous food.	
Probably also by deficiency of fat.	
By mere sameness of diet.	

The effects of want of vegetables, and the beneficial results from the use of lime-juice, are well known. With regard to the effects of deficient nitrogenous food, various cases are on record, one of the most striking being that of the Perth Penitentiary, as recorded by Professor Christison. Scurvy there came on in consequence of a ration of molasses being substituted for milk from motives of economy. On the milk being restored, the scurvy rapidly disappeared. It is true that here there were salts also concerned, for milk contains them in large quantities. Still I think it may safely be said that scurvy is likely to follow any material or prolonged disturbance of the equilibrium, which ought to be maintained between the different articles composing a diet, and that even with this equilibrium kept up, mere sameness of diet will after a time induce it. Once it is set up in a body of men, the most disastrous consequences follow—dysentery, diarrhœa, typhus, rheumatism, ulcers, &c., are sure to break out, and it besides leaves the system totally unfitted to resist any epidemic poison that may present itself upon the scene, so that cholera and typhoid fever find easy victims. To see the truth of these remarks we have only to look at the history of many campaigns. Scurvy seems to be everywhere, accompanied or closely followed by dysentery and typhus. We shall not be surprised when we bear in mind that the two main causes of these diseases are bad and insufficient diet and crowding, two causes which have almost always been but too generally present in wars. If there is more or less starvation without crowding, fever will always follow, but it is a fever of the relapsing type, and of itself rarely fatal; it, however, weakens the system extremely, and lays it open to attacks of other diseases. But if to starvation we add crowding, then typhus is inevitable.

Now, it is almost impossible, from the nature of things, to avoid crowding in war, as an army must necessarily occupy a smaller proportionate space than the most crowded city. In the Report of the Royal Commission of 1857, some calculations are given on this point. In East London, the most densely populated part of the kingdom, the number of persons per square mile is 175,816. To provide even the amount of space which this represents, we should have to give

300 square yards to each tent; but the area allowed is only 145 square yards, representing about 320,000 men per square mile. In some cases only 50 square yards have been given, representing 930,000 men per square mile, and it has not unfrequently happened that the tents have been pitched as close as they could stand, giving some 22 or 23 square yards for each, or representing about 2,000,000 persons per square mile, supposing that each accommodated only 15 men. Such a condition of matters is bad enough, but if to this we add food, both insufficient in quantity and bad in quality, what can we look for but all the long train of fatal diseases, which have too often decimated, and sometimes annihilated armies? Perhaps the most notable recent illustration occurred in the French Army, during the winter and spring following the taking of Sebastopol. As may be remembered, the French arrangements were somewhat better than ours at first, and they did not suffer during the first winter to so great an extent as we did, but during the second winter the conditions were reversed. Wise by experience, no efforts were spared by our administration to provide proper food and shelter for the troops, and the errors of the first winter,—less the faults of individuals than the inevitable results of an obsolete system, which a long peace had given no opportunity of correcting,—were most nobly repaired. The result was one of the most healthy armies ever known. The sick list was reduced in many cases below 1 *per cent.*, whilst whole battalions were often without a single man unfit for duty. On the other hand, the rations of the French soldier, far from improving, appeared rather to deteriorate, whilst crowding increased with the inclemency of the weather, and personal cleanliness was naturally much neglected. The Medical Officers foresaw what would be the result, and strongly urged immediate measures to be taken. As early as April, 1855, Dr. Levy warned the French authorities of the threatening dangers of typhus and dysentery in an epidemic form. In November, 1855, Dr. Baudens, Inspector-General, addressed a letter to the Minister of War, pointing out the insufficiency of the soldiers' diet, the want of fresh vegetables, &c., all tending to produce scurvy, and strongly enjoining the immediate issue of preserved vegetables, condiments, &c. He also called attention to the wretched tent accommodation, and the miserable clothing that the men had to put up with. That these prognostications were but too true is seen by the subsequent letters and reports:—

On the 8th of February, 1856, he writes, "Typhus threatens to "assume the proportions of a great epidemic." On the 11th, the number of cases is still increasing, but with the significant fact that as yet no officer (generally well fed and sheltered) had been attacked. By the 28th, fresh cases, at the rate of 150 to 200 per day, were declaring themselves, and several Medical Officers had already perished. The rapid increase may be conceived by the following abstract of the total cases and deaths, both in the Crimea and at Constantinople:—

	Cases.	Deaths.
November, 1855	16	8
December ,, ...	775	332

	Cases.	Deaths.
January, 1856	3,185	1,129
February ,, ...	7,834	4,339

And a most instructive table is added, comparing the French and English forces during February, 1856:—

FRENCH ARMY (strength 132,000 men).

	Admitted.	Per cent. of strength.	Died.	Per cent. of strength.
Wounded and general patients ..	11,732	8·8	1,190	0·9
Typhus cases	7,834	5·8	4,339	3·3
Scorbutic, &c.	6,772	5·1	349	·26
Total	26,338	19·7	5,878	4·46

ENGLISH ARMY (strength 70,000 men).

	Admitted.	Per cent. of strength.	Died.	Per cent. of strength.
Wounded and general patients ..	3,984	5·7	43	·08
Typhus	0	0	0	0
Scorbutic, &c.	34	·05	0	0
Total	4,018	5·75	43	·08

The death-rate in this ratio would amount in the French Army in one year to 58 per cent., or more than half the force, and this without much severe work, for the fighting was practically over, and the wounded trifling in number. On the other hand the English death-rate would have only been about 1 per cent. per annum, or little over that of the most healthy classes of the civil population. Altogether in the first four months of 1856, the French Army lost from typhus alone about 4,000 in the Crimea, and as many more at Constantinople, including about 40 or 50 medical officers. As regards the losses at Constantinople, these were hurried on and intensified by the crowding of the hospitals, consequent on the increased arrivals of sick from the Crimea. On the 1st of January, 1856, with 869 sick in the Daoud Pasha Hospital, Dr. Garreau reports the sanitary condition to be fairly good. On the 28th of the same month, there were 1,140 sick; from that day dates the rapid increase of typhus, for want of room had rendered it necessary to bring the beds closer together, and so crowd the wards. In short the state of things induced, was exactly parallel to that which prevailed in our own hospitals at Scutari, just one year before.

That we were enabled to show so marked a contrast in the second year was due to two main causes: 1st. To the free circulation at home of the actual truth, and the consequent rousing of public opinion to insist upon adequate measures of relief being adopted; and 2nd. To the fact that the Medical Department of our Army was an independent body, communicating directly, through its own head, with the Commander-in-Chief. In the French service, on the other hand, where the pernicious system of Intendance prevails, all representations and suggestions have to be filtered through the Intendant-General and his subordinates, the independence of the Medical Officer is destroyed, and his spirit crushed. It is true that a right of appeal exists from the Intendant to the General Commanding, but considering that all proposals of promotion or advancement in the Department are made by the Military Intendant, I leave it to the judgment of my hearers to infer how many appeals are likely to be made? It is greatly to be hoped that this evil system will, ere long, be abandoned in France, and the Medical Department placed on a similar footing to that of Prussia.

In criticising the diet usually issued to troops in war, I have not referred much to the individual details. I now wish to say a few words on that point. As Dr. Scrive says in one of his reports—"War "rations form a coarse diet, which ere long fatigues the stomachs of "the most robust." Even if they were given in sufficient abundance, their sameness and monotony are highly objectionable.

1. *Nitrogen.* A ration of a pound of meat, including bone, would probably be sufficient—provided that fresh and preserved meat were issued as often as possible, and salted meat as rarely as possible. Beef and mutton should be made to alternate as much as can be managed. As one pound of meat, however, would not yield enough of nitrogen alone, a small ration of cheese might be advantageously added, as well as a certain quantity of peas or beans—to be increased as extra work demanded.

2. *Fat.* This has always been deficient, and yet it is one of the most important articles for hard-working men. Indeed a mere increase of fat alone would often be sufficient in cases of extra work. Under any circumstances, a ration of bacon-fat or butter should be issued. It would be a good thing if the use of oil could be introduced into our Army; it is extremely wholesome and palatable, and I believe any prejudice against it would soon be got rid of.

3. *Starch, or Carbo-Hydrates.* This ingredient has always been rather in excess in the diet—at least in comparison to other articles; it would be better to diminish it a little, if fat were substituted instead, the potential energy of the latter being as 2·4 to 1 of the former. The best form is fresh bread, which ought always to be used instead of biscuit, when it can possibly be obtained. Potatoes and rice are also exceedingly good forms.

4. *Salts.* These have generally been rather deficient. In addition to the common salt used in bulk, it might be well to add potassium chloride, &c., in small quantities, should there be any difficulty about a supply of fresh vegetables—but it is by these that we ought to

endeavour to introduce them. No effort should be wanting to procure regular supplies of vegetables, either fresh or preserved, as the best safeguard against scurvy. Another article of great value, but much neglected in our Army, is *vinegar*, which should always be freely used in a campaign. It would be an excellent plan to get the soldiers to make salads with oil and vinegar, as a means of introducing both fat and salts into the system. For a salad it is not necessary to have carefully-culled lettuce, or blanched endive, or other garden refinements,—a very excellent salad can be made of many ordinary wild plants; dandelions, for instance, or any vegetables boiled and used cold, such as cabbage, brocoli, carrots, lentils, peas, beans, potatoes,—in short, almost anything that can be digested by the human stomach.

5. *Condiments.* These are of great importance. Mustard and pepper should always be issued, and, if possible, other spices as well. The judicious use of condiments makes all the difference between a grateful and appetising dish and an insipid and repulsive mess.

6. *Beverages.* Unquestionably the best beverages to work on, are *tea*, *coffee*, or *cocoa*, and these should be supplied without stint, and with plenty of sugar to sweeten them. Of course milk cannot be always looked for in a campaign, but when procurable ought to be issued, either fresh or preserved. As to the vexed question of alcohol, I am of opinion that the *spirit* ration is a mistake; but I think that a moderate ration of good *beer* or *red wine* would be beneficial. *Spirits* should never be issued, except on very special occasions, and then only on the recommendation or with the approval of the Medical Officer.

Tobacco is a substance that should also be supplied in moderation, as I believe most men are the better for a little of it, although, like alcohol, many can do without it altogether. In cases of extreme fatigue, I think great benefit would be derived from a liberal use of Liebig's Extractum Carnis. I know of nothing which so rapidly recruits the exhausted frame. It can be prepared in no longer time than is necessary to get water heated, or it may be taken, less advantageously it is true, cold. But I can conceive no more useful thing than a cup of the *tea* made from it, issued to men going on trench or picket duty on a cold wet night, or starting on a toilsome march. I believe it would do more than anything else towards keeping up their strength and spirits. Similarly, on coming off heavy duty, cold and weary, often too fatigued to sleep, a cup of it would be exactly what would be wanted to restore the balance of the disturbed and exhausted frame.

To sum up, then, I would propose as a war-ration some such diet as the following, to be varied as much and as frequently as the ingenuity or opportunity of the commissariat can devise, or as the skill of the cook can accomplish:—

PROPOSED RATION IN TIME OF WAR.

	Gross weight.	Water.	Albuminates.	Fat.	Carbohydrates.	Salts.	
	oz.	oz.	oz.	oz.	oz.	oz.	
Meat, 1 lb., less bone, say....	12·8	9·6	1·9	1·1	...	0·2	
Bread	20·0	8·0	1·6	0·3	5·9	0·3	
Potatoes	16·0	11·8	0·2	...	3·7	0·2	
Vegetables ..... (as carrots)	4·0	3·4	...	...	0·3	0·03	
Peas or Beans....	3·0	0·4	0·7	0·1	1·6	0·1	
Cheese.....	2·0	0·7	0·7	0·5	...	0·1	
Bacon-fat, oil, or butter	2·0	0·1	...	1·8	...	....	
Sugar.....	2·0	0·1	...	...	1·9	....	
Salt	0·5	....	...	...	...	0·5	
Vinegar.....	2·0	1·9	...	...	...	0·1	
Condiments	as required	....	...	...	...	....	
Tea	0·5	....	...	...	...	....	
or							
Coffee	2·0	....	...	...	...	....	
or							
Cocoa.....	2·0	?	0·3	1·0	0·5	....	and 1 oz. of alcohol
Beer.....	20·0	17·8	...	...	1·2	0·1	
or							
Wine (red).....	10·0	8·9	...	...	...	0·1	Ditto.
Totals	86·3 to 74·8	53·8 to 44·9	5·7 to 5·4	4·8 to 3·8	15·2 to 14·0	1·8	1

This would give of nitrogen, carbon, and salts, about:

Nitrogen....	375 to 390 grains	equal in potential energy to from about 4,800 to 5,300 foot-tons.
Carbon*....	5,300 to 5,930 „	
Salts	780	

Such a diet would, if properly varied, be amply sufficient for the ordinary fatigues of war, and might be easily supplemented in cases of extreme exertion. Could such a diet have been regularly supplied during the Crimean campaign, the horrors of the first winter would have been in a great measure spared us, and the ultimate gain, even at a great apparent immediate outlay, would have been enormous in a mere monetary point of view. Of course we should still have had our losses by the enemy's fire, but these are always trifling in comparison with the ravages of disease; besides which, in a truly hygienic force, but few of the wounded ought to die. Disease is the real enemy to dread, and the best weapon to fight him with, is good, abundant, and varied food; this given, our soldiers will easily contend with aught

* Not including the alcohol.

else. It may serve to illustrate what I have said if I state shortly the comparative losses by disease and actual wounds in action at different times.

Crimea. English Army.

Killed and died of wounds	4,602
Died of disease	17,580
Total	22,182

The admissions into hospital from wounds, amounted to only 11 per cent., and from disease to 89 per cent.

In February, 1855, at Scutari, the deaths to admissions were at the rate of 467 per 1,000.

In the *first seven months* of the war the mortality was at the rate of 600 per 1,000 per annum.

In the *last five months*, under a hygienic *régime*, the deaths were at the rate of 11 per 1,000 per annum.

Peninsula.

During the last three years ending in 1814, the sick and wounded amounted to 22·5 per cent. of the strength, thus distributed:—

Wounded	1·5
Sick	21·0
Total	22·5

In the French Army in the Crimea:—

During the *first winter* (November, 1855, to April, 1855), a period of hostilities giving 8,000 wounded, there were 90,000 sick and 11,000 deaths.

During the *second winter* (November, 1853, to April, 1856), a period of hardly any hostilities, giving only 323 wounded, there were 107,000 sick, and 21,000 deaths, of which 10,000 were from typhus.

In contrast to these, we have the examples of two campaigns, short certainly, but in hot countries, and at an immense distance from our resources, which show very different results, viz., those in China and in Abyssinia. In China, during the period of active hostilities, the following were the ratios of deaths:—

Total deaths per 1,000	65·54
Of these were killed and died of wounds	12·66

The greater part of the mortality was due to cholera, diarrhœa, and dysentery; but scurvy and typhus were absent.

Again, in Abyssinia, a country quite within the tropics, the results of the campaign were the following:—

Total deaths per 1,000	13·0
No deaths from action.	
Total sick admitted into hospital per 1,000	49·8

The health of the troops would have been much better but for the break down of the transport, and the consequent reduction of the rations to mere bread and beef, instead of the excellent and varied diet originally intended.

The happy results—although still falling short of what we should aim at—following the employment of true hygienic measures in these two short campaigns, as well as the wonderfully healthy condition of our Army in the latter part of the Crimean campaign, are highly encouraging, and prove on what sound principles the rules of hygiene are based. Let us only hope that these lessons may not be lost, and that should unhappily the necessity arise for putting to the test again the experience we have so dearly bought, we may not be found trying "how not to do it."

Evening Meeting.

Monday, May 23rd, 1870.

COLONEL W. F. DRUMMOND JERVOIS, C.B., R.E., Deputy-Director of Works for Fortifications, in the Chair.

NAMES OF MEMBERS who joined the Institution between the 16th and 23rd May, 1870.

LIFE.

Hay, Edward O., Lieut. R.A. 9*l.*

Robertson, F. W., Lieut 107th Regt. 9*l.*

ANNUAL.

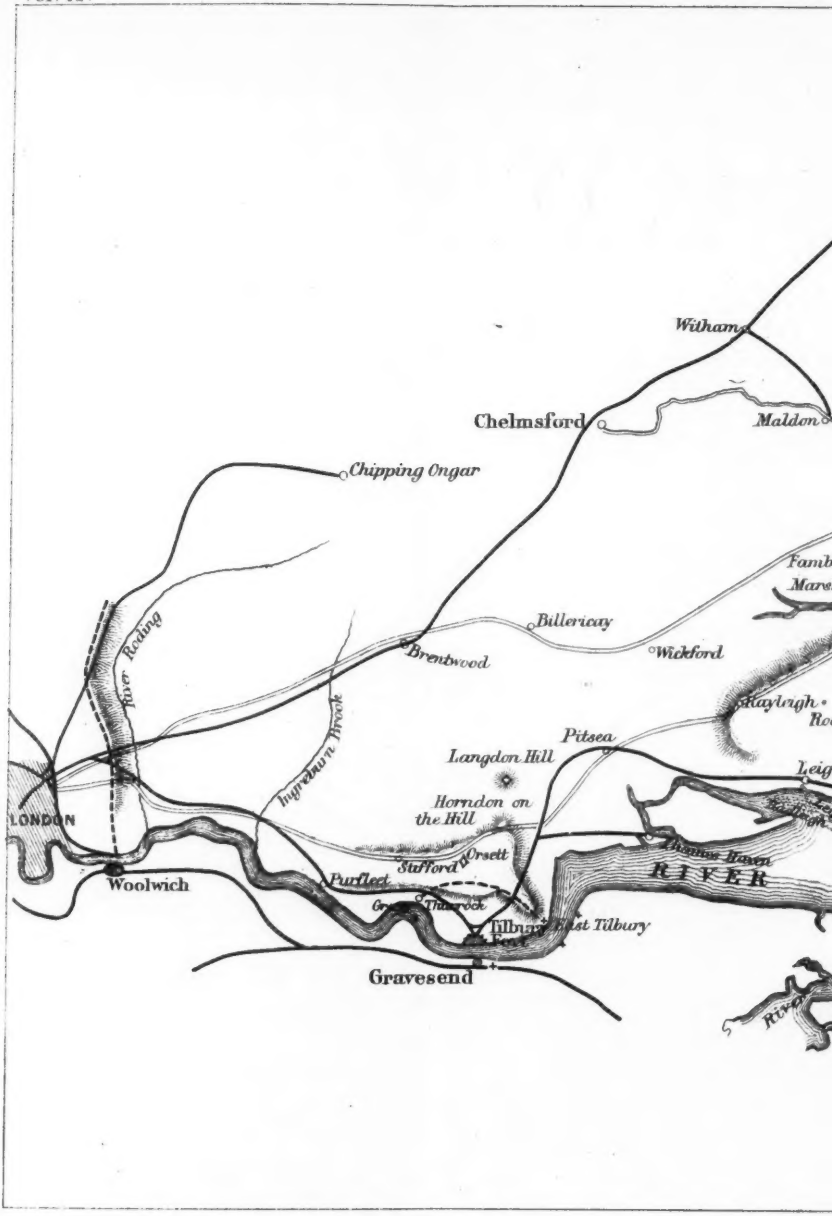
Wood, Thomas, Lieut. R.A. 1*l.*

Forsyth, Frederick A., Lieut. 5th Fusil. 1*l.*

ON THE PROTECTION OF LONDON AGAINST AN INVADING FORCE LANDING ON THE EAST COAST.

By Captain ALEXANDER B. TULLOCH, 69th Regiment.

ABOUT twelve years ago, this country was suffering from one of those periodical invasion-panics, with which we are all so well acquainted. But that panic differed from all previous ones, inasmuch as that, instead of gradually subsiding, and nothing coming of it, the alarm continued to increase. The warnings of those well qualified to give them were at length attended to, and a Royal Commission, composed of the most talented naval and military men in the country, was appointed to inquire into the matter. The instructions given to the Committee were "to examine into the state, condition, and sufficiency of the "fortifications existing for the defence of the United Kingdom, and "*especially* to all such works of defence as were intended for the "protection of the *Royal Dockyards and Arsenals.*" The result of the investigations and recommendations of that Commission has been, that the Royal Dockyards are now (or shortly will be) placed in such a state of defence, that no enemy, unless possessed of *unlimited* time and means would ever be likely to approach them with the intention of destroying or capturing them. Our Engineers may well be proud of their works, which have not only elicited the most unqualified admiration from every celebrated continental engineer who has inspected them, amongst others Todleben, but what is more to the purpose, they have come victorious out of every attack made upon them by those Members of Parliament who so jealously guard the public purse, more especially when it is drawn upon for naval or military purposes. Now, although no one can possibly dispute the necessity for a maritime nation like England making the bases of her naval strength invulnerable, yet I venture to think, that there is a subject of even more importance than the defence of the dockyards. I mean the defence of the capital. The instructions given to the Commission did not, however,


Witham
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Chipping Ongar
Billericay
Brentwood
Wickford
River Roding
Ingrebourn Brook
Pitsea
Langdon Hill
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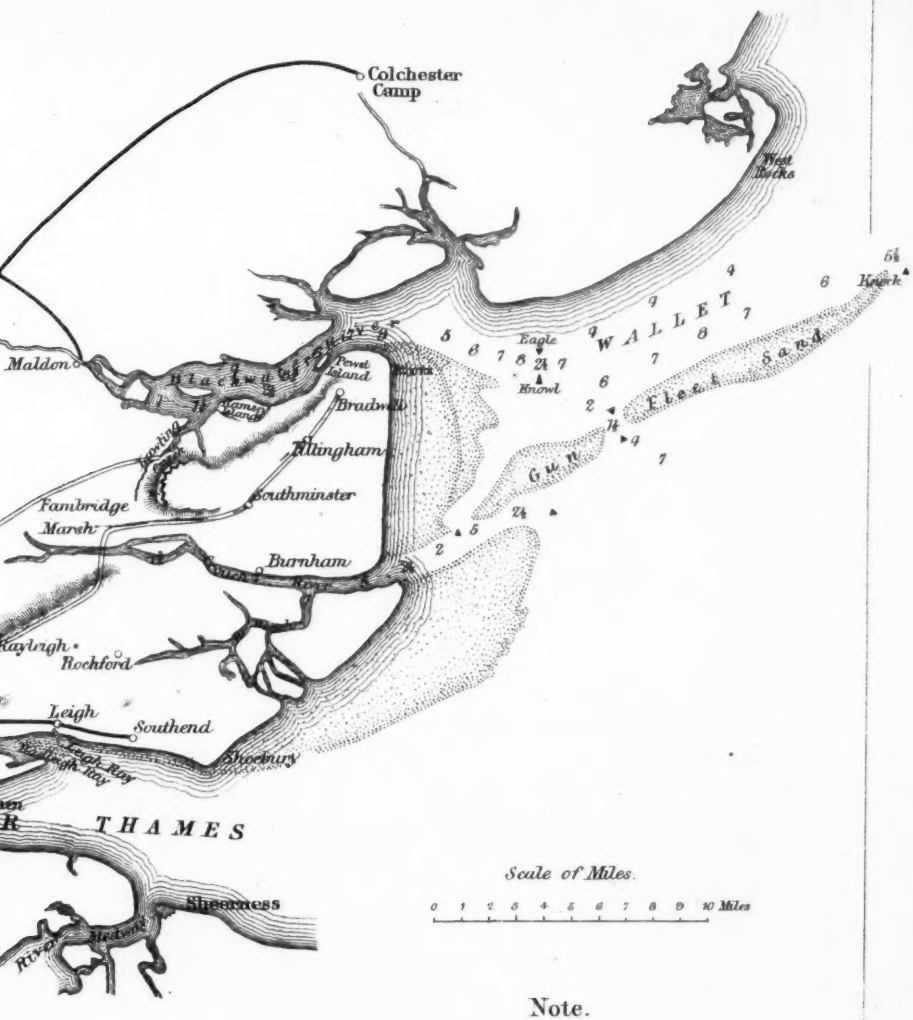
LONDON
Woolwich
Stifford
Orsett
Purfleet
Tilbury
East Tilbury
Gravesend
RIVER



Note.

The soundings are in Fathoms.

J. Jobbins

direct them to take the defence of London into consideration. In the Report it is so stated, with the remark that it did not materially affect the conclusions they had arrived at with regard to the fortification of the dockyards, except that the fortification of the dockyards by land would materially aid in the defence of London itself, for whilst by means of the system proposed, the vital points of the empire (the dockyards) would be protected against either capture or bombardment, the fortifications by land would set free the manœuvring army to act against the enemy.

The disastrous consequences likely to ensue from the capture of the capital are recognized in these words. "Whilst we are considering the "protection of the vital points against which an enemy, intent upon "inflicting a heavy blow upon the country, would direct his efforts, the "question of the defence of London presents itself. There can be no "doubt that the main object of an enemy invading this country would "be to push for the capital, in the hope that if he succeeded in obtaining "command of it, such a disaster would result in our buying him off "upon any terms he might think it expedient to exact."

It is perhaps hardly necessary to refer to the evidence of the distinguished Officers examined by the Committee, or to the many papers which have been written on the subject, to show, that London would be the prize a continental enemy would strain every nerve to gain, if they ever, by force of arms or diplomacy, obtained command of the sea.

That such a thing as the loss of our naval sceptre is possible, is practically demonstrated by the extent and power of the maritime works constructed in the last ten years, in accordance with the recommendation of the Commission. The circumstance of several plans, by both English and foreign Officers for defensive works round the capital, having been brought to the notice of the Commission is mentioned in the Report; but, as before stated, the defence of London was not part of their instructions.

I have read all the pamphlets on the subject which I have been able to obtain, and found various plans given, from enclosing London with an *enciente*, &c., in the most correct Vauban method, like the old French frontier fortresses, to surrounding it with a chain of detached forts, similar to those round Paris. The former method might have done 200 years ago, when London was rather smaller than it is now, and the latter, viz. (permanent detached forts) would, from the number required to make the London of even ten years hence, safe, be somewhat expensive.

Before going further, it will be necessary to ascertain, what powers, by reason of their proximity and naval and military strength, we have to take into consideration as possible adversaries. A glance at the map will show them to be three in number. France, Russia, and Prussia, the united fleets of which might some day be arrayed against us. The coalition of any two of them—even Russia and Prussia, as naval powers, will probably in a few years be a matter for serious reflection. As far as a land force is considered, France or Prussia alone could furnish as many troops as would be required for an invasion of this country, provided they could establish a secure base on the coast in

communication with the continent. Ten years ago, France was the only nation to be taken into consideration, and consequently every one, for very good reasons, looked to the south coast as the line which would have to be guarded. In some schemes for defence which I have read, it was supposed that the French might invade this country at several points at once—from Cornwall to Kent; the presumed advantage to the enemy being, that we should be obliged to divide our army into as many fractions as his, each to fight on its own account; and that as the French would be stronger in each case, we should probably be beaten, a circumstance not unlikely if any English General divided his army into several parts simply because his adversary did so.

But to return to my more immediate subject, Russia, and Prussia especially, are working hard to become formidable maritime powers, the latter nation, amongst other things, being now about to make a ship canal from Kiel across the Isthmus to the German Ocean, an opening which would enable her ships, and also those of Russia, if acting in concert, to debouch from a point within 320 *miles* of the Nore, just 28 hours' steaming, so that the base of a possible enemy, instead of being simply the north coast of France, may now be said to extend from the mouth of the Elbe to Brest, an arc whose centre, looking at it roughly, is somewhere opposite the mouth of the Thames.

The question then presents itself thus, the royal dockyards are, or soon will be, safe; the capital is without direct defence of any kind against an attack by land. Supposing that any of the great continental nations had command of the sea even for a limited time, what course would any of them singly, or in coalition, adopt for striking this country the most deadly blow possible?—unquestionably he would devote all his energies to the capture of London, which would be the greatest disaster he could rapidly inflict. Let us examine what would be his chances of success?

Eleven years ago, at the time the Commission was engaged in its investigations, the force which England could reckon upon for home-defence was nothing like so powerful as it is at present. The Thames was quite open, the defences of both Portsmouth and Dover by sea and land were so weak, that a powerful enemy might have calculated on their capture by a *coup-de-main*, and either place would have given our adversaries an excellent base. In addition, supposing Portsmouth and Dover to have been neglected, there are three or four small harbours between these places, any of which, after the landing of the enemy, might at that time have been available to keep up communication with their fleet even in bad weather. But eleven years have made a great difference in the defensive power of this country, not only as regards the impregnability of the dockyards, and the number of regular troops and volunteers which could be placed in the field, but also in the ascendancy which defensive has acquired over offensive warfare when a seaboard is concerned. I refer principally to torpedo operations, which have been brought to a much greater state of perfection than is generally known.

I venture to think that in future the guns of forts will, in certain special positions, be used more to prevent any attempt at clearing

torpedoes away than in direct action. As long as a channel continues blocked by good and powerful torpedoes, no ship dare venture over them. By the aid of torpedoes and other rapidly constructed obstacles, supported by small independent forts, which could stand a week's siege such as that at Newhaven, all those small harbours between Portsmouth and Dover could be denied to the enemy. Land he undoubtedly might at several places on the south coast, such as the level between Pevensey and Hastings, where gun-boats could easily clear away anything that opposed them, but unless he could find some harbour at hand by which he might maintain communication with his fleet in all weathers, a landing anywhere between Portsmouth and Dover would not answer his purpose, and to look for a base to the west of Portsmouth would place him too far off in point of time from his object, and any line of operations drawn from London westward of that seaport would be in danger on its right flank from the garrison there.

Similarly any landing on the Kentish coast eastward and northward would bring a line of operations in dangerous vicinity to Dover, Chatham, and Sheerness. Finally, if an enemy did think a landing advisable on an open beach, such as Pevensey, midway between Dover and Portsmouth, and an immediate advance straight on London, as Napoleon proposed in 1805, he would find that between the coast and London lay one of the most defensible tracts of country in England. No one who has not reconnoitred the country, can possibly imagine how well suited the greater part of Sussex is for an army acting on the defensive against an invader from the south. Position after position extend one behind another almost to the capital.

If that carefully prepared army of Boulogne had been able to cross the channel and land on the open coast—and recent publications show how nearly successful Napoleon was in his naval arrangements for ensuring them a safe passage—that army might in those days have marched straight on the capital with so many chances of success in its favour that it need not have lost time in securing some harbour as a base before leaving the sea; besides, the first success would probably have given them three or four ports to chose from.

Now it would be very different. In the first place, as already stated, all the large ports mentioned will shortly be impregnable, and the smaller ones could soon be made useless. The forces at the disposal of the country when the system for their organisation is fully completed, will be superior to what it had 65 years ago, and they had not then that immense power of being able to concentrate by rail as we now have. In addition to that, breech-loaders wonderfully increase the power of defence when used from behind "shelter trenches," covered by abattis, which are so easy of construction, especially in a wooded country like Sussex. I am informed, that when either side, during the late American war, could roughly make a log breastwork of three or four trees, with a few felled in front as obstacles, that in no case were they successfully assaulted by the opposite party, and muzzle-loaders were the arms used at that time.

In the present day an army landing on the coast, and throwing

itself into the country without having secured a base would, by the first check it received, be placed in a decidedly critical position, and unless the defensive power of this country is lessened by the reduction of the regular forces, and the subsidence of the Volunteer movement, I think no enemy will now be likely to land on the open coast and attempt to take the capital by a *coup-de-main* from the south.

Having thus roughly shown the difficulties with which an invader would have to contend, it will naturally be asked, How, then, can an enemy possibly expect successfully to invade this country?

From what I have already stated, the south coast from Southampton to the Thames appears to be safe. If the enemy can similarly be prevented from obtaining a suitable base from, say Harwich southward, he will in point of time be then so far away from the capital, that it may practically be considered secure on all sides (that is as soon as the forts blocking the Thames are finished).

At the beginning of this paper, I pointed out that the enemy's primary base must now be considered as extending from the Elbe to Brest, an arc whose centre is about opposite the Nore; if then they can find suitable anchorage, harbours, and landing-places near that spot, it would be highly advantageous to them by giving a central point for concentration, and it would be exceedingly dangerous to us from its proximity to London.

That such undefended anchorages, harbours, and landing-places exist, I will now endeavour to show.

Ten miles northward from Southend and parallel with the Thames, is the River Crouch, and eight miles north of the Crouch is the Blackwater.

At Burnham, on the Crouch, five miles from the sea, that river is as broad and deep as the Thames at London Bridge, and the Blackwater is an estuary about the size of Southampton Water. The country lying between the two rivers, is one of the most admirably adapted districts for a base of operations that could possibly be found.

With regard to the anchorage outside these rivers, between the Gunfleet Sand and the Suffolk coast, there is, according to the North Sea Pilot, a good and safe holding ground called the Wallet, about 10 miles in length, and from three to five in breadth, sheltered by the Gunfleet and the Suffolk coast, as in a similar manner the anchorage in the Downs is protected by the Goodwin Sands. The passage from the Wallet into the Blackwater with a pilot is easy; there is only one small portion between the Knowl and Eagle buoys which is at all cramped, but even that is half-a mile in breadth, and at dead low-water spring tides, is from 15 to 22 feet deep, and but a small portion of it at one side only is so shallow as 15 feet. Spring tides rise 10 to 15 feet. Once past this, there is room and water enough in the Blackwater for a fleet of line-of-battle ships. Some idea of the size and capabilities of the passage may be formed, when I state, that between the buoys, the water is broader and deeper than the Thames at Woolwich, and many large ships pass that town every 24 hours without much difficulty.

The passage from the Wallet to the Crouch is not so easy, and only

9 feet of water is found in the shallowest part. The passage by the Whittaker Channel, however, on the south of the Gunfleet into the river is almost straight. It must not be forgotten that the soundings given are those of dead low-water spring tides, and that at high water 15 becomes 30 feet, which is enough, and a good deal to spare, when we remember that a 4,000 ton transport like the "Serapis," only actually draws 19 feet.

As regards landing-places, when the tide is up in the Blackwater, you can get on shore anywhere; when it is out, the mud is decidedly inconvenient, but there is still enough natural wharfage available. Between Peewit Island and the shore, there is ample water for boats, and a good landing-place three-quarters of a mile long at all times; there is also hard ground fit for landing for some distance along the east side of Romsey Island.

On the Crouch there is plenty of hard landing ground, at any time of the tide, in the neighbourhood of Burnham.

With reference to the country which lies between the two rivers, it is about 50 square miles in extent, two-fifths of which are marsh meadows, and the rest fine undulating, corn-growing ground, well supplied with provisions and water. There are three small towns, Burnham, Southminster and Tillingham, and several hamlets, few gentlemen's houses, but numerous large farms, whose well-filled stack and cattle yards would much delight the commissariat department of the invader, and on the marshes he would find still further supplies of meat and forage; those great grass plats being covered with sheep and cattle. The enemy could easily hold the country between the rivers, once having gained possession of it; from Lawling Creek on the north to Faunbridge marsh on the south, is only about two miles, the ground between being well adapted for an entrenched line looking west. In addition to the supplies which might be obtained between the Blackwater and Crouch, the country between the latter river and the Thames would also be available; I mean all inside a line drawn from Hall Bridge (a point to which the enemy's gun-boats could reach) to Hadleigh. Any force which might previously have been inside that line, would have to retire at once on pain of being captured.

A landing by the Blackwater and Crouch rivers would naturally be assisted by feints on other parts of the coast. Some of these might be turned into real landings, such for instance as one near Leigh. At high tide there are 10 to 12 feet water in the creek at the end of the small pier there, and at low water the mud is hard enough to walk upon. A small force landing there would assist, and be assisted by, light draught gun-boats which could push up the Roach to within about a mile of Rochford.

Another demonstration might be made by a small portion of the fleet towards the piers at Thames Haven, where they would be just out of range of the Thames forts' batteries. They would there be at hand to signal and stop any interrupting force sent down the river, and would also be in a position to assist that portion of the fleet which would be blockading Sheerness. It would hardly be feasible to torpedo the river (if I may so term it) till it narrows sufficiently to do so near the

batteries below Gravesend. I should say, however, that if torpedoes could be protected at Thames Haven, the river is narrow enough just opposite the piers to permit of their being used there.

An enemy having secured a base between the Blackwater and Crouch, would now be admirably placed for an advance on London. All that difficult country of Sussex, and all the strong places on the south coast would be turned; the Thames would be a protection to their left flank, till they came upon the position that might be taken up by the defenders to cover London, which would probably be along the line of the Roding and Barking Creek.

Although the enemy's ships might not be able to pass the forts near Gravesend, those forts might be "contained" on the land side by a small force on the hills round Tilbury, which are within easy range. A few heavy guns landed at Thames Haven might make the holding of the forts a matter of some difficulty, indeed some believe that if an enemy succeeded in establishing himself on the Tilbury hills, he would be but a short time in causing the evacuation of Coalhouse and Tilbury Forts, and if that were done, the river on the northern side could be sufficiently cleared of obstacles to allow ships to pass up.

But admitting that the forts were held by us, and the hills by the enemy, it is plain no bridge could be made there then, and it would be hazardous and unprofitable to make one anywhere between Gravesend and the position intended to be held on the north bank higher up; therefore, I say, the river would be a protection to the enemy's left flank.

The country the enemy would have to pass through is singularly devoid of defensive positions; it is open enough for the movements of infantry, and yet not so open as to permit the action of cavalry. This would be in the enemy's favour, as it would justify him in reducing the number of cavalry horses, which might otherwise have been necessary, a great consideration when the difficulties of horse transport are considered. The shortness of their line of operations would also be greatly in their favour, when the amount of transport animals required has to be thought of. It is almost incredible how rapidly the number increases in direct ratio with the length of the line of communication to be kept up. In the present case, cavalry, perhaps 3,000 or 4,000, artillery, reserve ammunition, engineer train, and mounted Officers' horses, might almost be the only ones required, the expedition might fairly count on capturing a large number of horses and carts on landing. At 7 horses per 100 cultivated acres in Blackwater Crouch country, at least 1,500 horses should be obtainable, and an equal number by a rapid forage between the Crouch and the Thames.

Such are the advantages an enemy would have in forming a base at the point mentioned, which is 36 miles (only three marches) in a direct line from the centre of London, on which he might safely advance, his right crossing the upper Crouch, and moving *viâ* Wickford, Billericay, and Brentwood, his left going *viâ* Rayleigh, Pitsea, Horndon-on-the-Hill, and Stifford, coming dangerously close to Woolwich, and perhaps destroying the Purfleet magazines, *en route*. No good position could well be found for stopping them before they got within

six miles of London, namely, on the Roding, where the loss of a single great battle so close to the metropolis would probably terminate the campaign disastrously for this country.

Having thus briefly pointed out the facilities which exist for the advance of an invader on London, I will now endeavour to show how a line of invasion by the north side of the Thames, which now seems dangerously practicable, may be defended.

The plan of enclosing London with detached forts would undoubtedly be a great protection, but when the immense area to be sheltered comes to be considered, the number of forts required would be so great, that no Parliament in the present day would ever be likely to grant the money necessary for their construction. Although it would be only essential to fully man those forts on the side towards which the enemy were moving, all the forts would be obliged to have their proper complement of guns and heavy stores.

If the system usually adopted for the protection of other places be inadmissible in the case of London, how then can a powerful enemy be stopped in his march from the Blackwater and the Crouch, when no naturally strong positions can be found crossing his line of advance, on which the defending army could entrench itself, and bar the road to the invader.

Evidently, if no direct obstacle can be found, some indirect one must be placed which shall cause him to halt or turn away from his intended line.

To the north of Tilbury Fort, 1½ miles distant, is a range of hills to which I have referred. These hills occupy an arc of a circle whose centre is about Gravesend. The arc is 7,000 yards in length, and strikes the river on the east at East Tilbury, and on the west at Thurrock. By occupying the heights with eight strong field works, well supplied with artillery, and connecting both banks of the Thames by a bridge from Gravesend to Tilbury, I think you would have such a strong *tête du pont* and place of arms for the assembly of a force to act on the enemy's flank, that he dare not neglect it and continue his march, more especially when one remembers that his left would move by a road rather under two miles from the entrenched position. On making a rapid reconnaissance of the ground in question, I came to the conclusion that about eight strong field works, connected by a line of entrenchment, suited to the nature of the ground, would be sufficient. But when the importance of the position comes to be duly considered, I think the expense of more perfect permanent works on two or three of the most important points would be justifiable. It may be said that an enemy might pass your position, leaving a comparatively small number of troops in your front, and disposing them in such a way as to make you believe they were the main body of the army. That objection can, I think, be overcome. At 4½ miles from the right front of the position is a remarkable elevation called Langdon Hill. From this hill, which is 378 feet high, the country can be seen and investigated for miles round. Now, whether the Tilbury hills are occupied with permanent or field works, it would unquestionably be necessary to hold the summit of Langdon Hill with a small

permanent, independent work of such strength that it might safely be calculated to hold out for a week or ten days. The work would not be required for the purpose of taking an active part in the defence of the entrenchments, but merely for the preservation of a party of signallers who could signal from Langdon to the entrenchment, the movements of the enemy. From the peculiar formation of the hill, it would be easy to construct a work on the summit, which would be difficult to attack.

Another independent work in front of the position, at Orset, where there is a good view over the country, might be deemed necessary in the event of very thick weather. That work would receive a certain amount of support from the line in rear. With those look-out posts, and an energetic system of reconnoitring, the enemy would hardly be able to deceive the General in command at Tilbury, even for an hour.

As regards the construction of the field-works, supposing that their trace and position had been definitely settled beforehand, three or four days' and nights' continuous work, when the amount of labour and material to be obtained was unlimited, as it would be in this case, would be sufficient for the formation of works of 8 feet command, and with parapets thick enough to resist field artillery. Each work should be enclosed, armed with twenty to thirty guns, and have field bomb-proofs for at least two-thirds of their garrisons, which should be of about 500 or 600 men each. The guns and heavy stores for the intended works might be kept in Tilbury Fort till required. The proximity of the place to London, Chatham, and Woolwich would indicate where the men and material necessary for constructing the works could be got.

With regard to the formation of the bridge, it would certainly be a considerable undertaking to throw one across a river half a mile in width; but I am sure that any one who has seen how the engineers can overcome what appear insurmountable difficulties in the matter of bridging, will have no hesitation in saying, that they would be equal to the occasion. Large Thames barges would probably be the best kind of boats to employ. Supposing that the plan on which the bridge was to be built had been previously arranged, and the material brought to hand, I do not think it would be too much to expect of the engineers that they would finish the bridge by the time the forts were ready. I cannot help thinking, however, that in a few years the question of having a bridge, need not be taken into consideration. The science of making submarine, or rather subfluvatile tunnels, has progressed at so rapid a rate, that I believe it to be only a question of time, and that a very short time, before the railways at Tilbury and Gravesend will be united by a tunnel under the river. I am aware that one was attempted there some time ago, and that the rotten nature of the chalk allowed the water to come in at such a rate that the work was brought to a standstill; but that was before the method of driving a tunnel and tubing, or tubbing it, as, I believe, it is technically termed, was so well understood as it is now. If a tunnel were projected under the Thames at Gravesend, the Government should give it every encouragement, on account of the strategical value which it might some day have.

The value of having such a position as I have described, I fancy no one will deny. The first decided indications of our having to measure our strength with the nations or coalitions I have referred to, should be the signal for the construction, arming, and garrisoning of the works; and if a tunnel had not then been made, for getting together and preparing in lengths the bridge, so as to be ready to throw it across the river in a few hours.

Part of the field force for the defence of the country would, I suppose, be massed at certain strategical points, covering London, and all well in hand ready to move on any spot indicated. Yet as it would not do to have all the available troops drawn too close to the metropolis, —certainly not till the enemy had shown his line of attack—and until that became apparent, a small force on Tilbury heights would be as conveniently placed for transport to other parts, as they would be at Aldershot or elsewhere.

When the importance of the Thames batteries is considered, it will probably be thought necessary to have a force permanently at hand for their support; thus the garrisons of the forts on the heights would answer a double purpose.

The works being garrisoned, let us suppose the enemy to have succeeded in landing and forming a base, he would then push strong advances to his right and left-front as rapidly as possible; that on his right being to destroy a portion of the Eastern Counties Railway, with the object of cutting off any assistance that might be coming from the eastern counties to London. The left advance, aided to a certain extent by his fleet, would make for the Tilbury heights in the hopes of gaining the objects already mentioned. But if, on the other hand, the Tilbury hills were so strongly occupied that the enemy dared not attack till his main body came up, then, as every hour would see, the disposable forces of Kent sent up in a continuous stream by rail across the bridge, and on to the position; the General commanding there would receive reinforcements quicker than the enemy, and would soon be powerful enough to hold his line against any attack.

While the troops from the south-eastern and adjacent districts were being placed in the intended line, the rest of the forces of the country might be rapidly getting into a previously-selected position on the Roding, or one further forward, if obtainable, covering their line with entrenchments and connecting themselves with the south bank of the river by one or more bridges near Woolwich, behind the right flank of their position, which would be protected by guns on the high ground of the south side.

The two lines now taken up would be about ten miles apart; they would be in communication by the bridges, the Woolwich and Gravesend Railway, and the roads on the south bank. I ought, perhaps, also to state, that the lines at Tilbury would have another advantage; from their position they would paralyse any attempt at an extensive landing anywhere between Shoeburyness and Thames Haven.

The reinforcements sent up by railway from the south and south-west of England might, by being directed on some particular railway junction near Woolwich, be available for sending to the Tilbury or

Roding positions as required. With the lines at Tilbury thus ready to act in support of the Roding position, it would, indeed, be a bold and powerful enemy who dare advance on London before he had rendered his left flank secure by capturing these proposed lines.

It may be said that when an enemy found himself stopped in front and on his left flank, that he would turn away to his right, and come down on London from the north; but everyone who has studied military history knows the danger of attempting a flank march in front of an enemy, and in the present case, I venture to think, it would be so dangerous that he would not dare to risk it.

One of the most important, if not *the* most important thing to be remembered in war, is the value of time. Therefore, with the object of delaying the enemy as much as possible, it would be advisable to place every obstacle in the way of his gaining possession of the two rivers which are essential to him in forming his base. The entrances of both of them are too wide to permit of their being stopped by sinking ships filled with stones. From the nature of the ground on both sides of the mouth of the Crouch and on one side of the Blackwater, I doubt very much if good foundations could be found for heavy sea batteries at those places; if such turns out to be the case, *and forts are found to be impracticable*, one way in which I fancy the Crouch and northern half of the mouth of the Blackwater might be blocked for a time, would be by securely mooring in those places a torpedo-ship. I do not mean a moving torpedo-boat, but a round-backed, heavily-plated iron monster, surrounded by torpedoes, the wires being laid along the bottom of the sea till they came underneath the ship; they might then be conducted to the firing-room, securely attached to some heavy cable. In addition to the torpedoes which the ship could fire at will, she might also protect and be protected by two or three rows of "self-acting torpedoes;" the ship to be placed behind a line of floating obstructions, which would prevent her being rammed by a torpedo-boat or anything else. As long as the torpedoes were down, it would be dangerous work for ships to try to pass the Channel. The monster might be furnished with guns in turrets, or other approved methods of replying to fire, and so keeping off daring gun-boats which might try to remove the obstruction. With the aid of the electric light and a couple of steam-launches to patrol to the front at dark, the ship might almost be as unapproachable by night as by day.

There is a good position for a battery on the south bank of the Blackwater, but at present both rivers named are perfectly open, and by them lies a road to the heart of the country, free from obstacles, and very inviting to an enemy.

If I have succeeded in drawing attention to the line in question, the object with which I venture to read this paper will have been fulfilled.

The CHAIRMAN: I am sure that we are much indebted to Captain Tulloch for the interesting paper he has just read. Though the particular features of invasion and defence, to which we have this evening been introduced, are not altogether novel, they are probably unknown to the public at large, and may possibly have escaped the attention of many members of the two services who are here present. I think we must feel grateful to Captain Tulloch for having brought

before us the points to which he has referred in so clear and able a manner. At this period of the evening I will not offer any critical remarks upon the subject under consideration, but I would invite any gentleman present to commence the discussion. Perhaps, as Captain Tulloch's proposals involve the acceptance of certain conditions dependent—both for offence and defence—upon naval operations, Sir Frederick Nicolson would give us the benefit of his opinion on their feasibility. For instance, we should know in detail the capabilities of the Crouch and the Blackwater for invading operations, and that of the Wallett as an anchorage for a naval force. We should also know whether an enemy could establish a good naval base of operations in that quarter; in short, I propose to the meeting that Captain Tulloch's proposals should be firstly considered from a naval point of view.

General Sir WILLIAM CODRINGTON: Without attaching any great importance to the observation, I should like to call attention to the question of the enemy getting a base of operation in the Wallett; perhaps Sir Frederick Nicolson will be able to say whether that is a real anchorage? is it not exposed to the north-east gales very much? Surely that would not be getting a good base of operations unless the enemy could get into the river, and land their men and stores there?

Admiral Sir FREDERICK NICOLSON: I rather rise with the object of asking questions, instead of answering them, for I am certainly not well acquainted with the details of that part of the coast. The Hadleigh Ray I do know something about. I doubt whether any man would like to take his gun-boats up Hadleigh Ray, with the chance of being left aground at the ebb tide. The other two rivers I do not know.

Captain TULLOCH: With regard to the anchorage of the Wallett, the *North Sea Pilot* gives this passage:—"Besides the shelter afforded by the West Rocks in "easterly gales (as noticed on page 186), there is also a well-sheltered anchorage in "every part of the Wallett in gales off shore, as well as those from south-west to "south-east, for the high sands which bound it intercept all weighty sea, and it "becomes comparatively smooth at two hours' ebb. The precaution should, however, be adopted of giving a good scope of cable on first taking up a berth, for, as "the bottom is of stiff clay, the anchors become shod, and will seldom hold again "after they have once started." With regard to Hadleigh Ray, an expedition there would be merely a feint to divert attention from the main attack. At dead low water there is no water at all in the Ray at the end of the pier.

Sir FREDERICK NICOLSON: What is the depth of water in the other two rivers?

Captain TULLOCH: Unfortunately I have left the paper behind me which I had with regard to the soundings. At dead low water the Blackwater has a depth of from two and a quarter fathoms to six fathoms; inside it is perfectly sheltered, and there is room for a large number of vessels. In the Crouch at dead low water there is ten feet water, and just below the town of Burnham there is a large shoal called the Whale Shoal, on each side of which there is a deep channel. At dead low water the Blackwater is a good half mile across.

Sir. F. NICOLSON: At two and a half fathoms?

Captain TULLOCH: I will not be sure that it is two and a half all the way across; I should suppose it is six fathoms at the mouth, and gradually diminishes to two and a half further up.*

Captain BURGESS: Laden brigs go up as far as Maldon.

Sir W. CODRINGTON: What is the distance from the coast to London?

Captain TULLOCH: From the mouth of the Blackwater it would be about forty-four or forty-six miles.

Sir W. CODRINGTON: And from the coast of France across?

Captain TULLOCH: From the extremity of the base at Brest?

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* On referring to the memoranda which I had unfortunately mislaid, I find the soundings to be *not* 2½ to 6 fathoms, but 3¾ to 9 fathoms! The soundings stated throughout the paper are those given by the Hydrographer's Department at the Admiralty.—A. T.

Sir W. CODRINGTON: No, from Boulogne?

Captain TULLOCH: It would be much shorter; it is a very short distance, indeed, from Boulogne across, about sixty or eighty miles, but I took the distance from Brest, the extreme point.

Mr. S. MACKIE: I would suggest one observation with regard to the subject that has been brought before us by Captain Tulloch. It seems, on glancing at the map, that there is at any rate a certain amount of probability that an enemy could attempt a landing on that coast. Two years ago I had the honour of reading a paper in this room on floating batteries. On that occasion I drew attention to one particular design by Mr. Moody. It seems to me that, if these batteries are to be of any value whatever with regard to coast defence, and I think they are of value, it might be worth considering how far they could be made available in stopping up those entrances of the rivers which the enemy's ships must pass, in case they made a descent on that part of the coast. I take it that Captain Tulloch is perfectly right as to the progress of the enemy after he has landed, therefore it seems to me an important point to bar his entrance into those two channels. Captain Tulloch has suggested that a torpedo vessel, surrounded by torpedoes, might be placed there. I also understood that the same torpedo boat might carry guns for her own defence. As there is a considerable width of water there, a vessel of shallow draught, such as those designed by Captain Moody, entirely coated on the upper surface with armour, might answer, because she would bar the entrance in the centre of the channel which she would command with her guns, while from her light draught of water she would be able to manœuvre over the sands, and thus be a further serious annoyance to the enemy. It seems to me that at a comparatively small expense, a very effective floating battery might be placed at the entrances of those two channels. In time of peace they might serve as light-ships to the rivers, if necessary. At any rate, with their power of manœuvring, and with their heavy armour over the deck surface, they would be a strong protection to the coast there.

Captain BURGESS: It may be of interest to the meeting that I should mention, that this part of the coast was not left undefended by the Romans; they had a fort (some say a city) at the mouth of the Blackwater, at Oithona, the remains of which were found lately when digging materials for a sea-wall. The walls of this fort or fortified town, which appears to have been swallowed up by the sea, are now distinctly visible. There was also a Roman camp at Maldon.

Mr. MACKIE: The Danes also entered the Crouch river, and fought a celebrated battle at Cancurdon. If the Danes could get up I suppose modern sailors would be able to make the passage also.

Captain HOSEASON: I should like to ask, have you considered the amount of force that the enemy would bring against us in cavalry, infantry, and guns, and consequently the amount of shipping that would be required to move them? Because that would mainly determine whether the anchorage you speak of is capable of holding them, or whether the force that we could collect to oppose the landing, would have a chance of success. We invaded the Crimea with about 33,452 men of all arms, 54 guns, and 3,349 animals. The French had to land a smaller force, with but few cavalry, and yet the joint expedition numbered 400 vessels, including men-of-war. I do not conceive that any invading army would be permitted on landing to derive much from the resources of this country, either in food for their animals or men, for the debarcation would be soon known all over the country, and the supplies you count upon, driven away or destroyed. With ample time for preparation, and without encountering an opposing force, we were not able to bring over in the transports to land in the Crimea, more than 75 commissariat animals.

Captain TULLOCH: The least number of men, as far as I could think of, would probably be about 120,000 men.

Captain HOSEASON: How many animals?

Captain TULLOCH: If the communication was a line of communication 150 or 200 miles long, the animals would be at least 100,000.

Captain HOSEASON: That is very far short of what I should make it.

Captain TULLOCH: But in this case it would be very different, the line of communication from the base being so short, hardly forty miles. Perhaps I may be permitted to quote a remark from a very good book by Lord Dunsany, *On our own Naval Position and Policy*. He touches on this very subject, and he quotes from Prince Joinville with regard to the Crimean war:—"The Prince considers that the "Crimean expedition affords an example of the shipping required by the French army. "He tells us that the French expedition, comprising 29,000 soldiers, 68 field pieces, "and 2,900 horses or mules, was embarked in 97 ships and vessels of all sizes; that "there were also some merchant ships laden 'pour l'intendance' with stores, but "not immediately necessary for embarking. To carry 60,000 troops, therefore, 200 "such transports would be required, and even then there would be no cavalry. But "we must remember that steam ships are increasing in size every day." Lord Dunsany then adds in a note:—"There is nothing so fatal in war as the habit of "*creating* conventional impossibilities or insuperable difficulties, and among these "may be classed the imaginary obstacles to the embarkation of an army. A far less "amount of transport than is usually employed can be made to serve the purpose. "Thus, the first part of the French expedition to Rome, in 1849, consisting of 10,000 "men, were embarked in six steam frigates, three *small* steam sloops, and two "transports, carrying with them their whole material, for a voyage of about 300 "miles. During the same operations one steam frigate carried 2,000 soldiers with "their necessary ammunition and equipment. Even with those ships, fifty-four "steamers and twelve transports would carry 60,000 men. With this precedent it "would be dangerous to calculate on the absolute necessity of the large amount of "transports usually employed; the same rule holds with reference to land trans-"port." With reference to my own ideas on the subject, I contemplate a merchant steam ship of 1,000 tons as a good average size for calculation. On board such a ship I remember 500 men being carried out to India in 1857, viâ the Cape, very comfortably; for a passage of 30 or 40 hours I think we might safely allow that that steam ship could carry three times the number of men she took to India; each steamer might tow four horse-boats. With regard to the horse-boats I got a friend well acquainted with ships and large boat building to make the required calculations for me, on the supposition that each horse-boat should be able to carry 50 horses comfortably, with space for forage, and also for men to attend to the horses and the boat; there was also to be room to stow three or four gun-carriages, limbers, and waggons, the boats to be of such strength that they would stand being towed after a steamer for 320 miles even in moderately bad weather; the horses were to be protected by some light but strong covering from rain or spray. The answer I received was that with 20 men working continuously, night and day, such a boat as I described could be made in 14 days, withdouble the number of men 10 days would be sufficient to complete it, horse fittings and all. Supposing each steamer on an average took 1,500 men, and towed four horse-boats, an easy task for a steamer of 1,000 tons; the number of steamers required to transport the Army is a mere matter of calculation, 100 steamers towing 400 horse-boats should be sufficient; in addition to the men each steamer could carry a large quantity of stores (provisions and ammunition).*

Sir FREDERICK NICOLSON: I suppose the first assumption you make is, that the Medway is blockaded, so that no naval force of ours could get out of it, or out of Sheerness, because I presume you would hardly place that large number of transports, to say nothing of horse-boats, near the Medway unless the Medway was blockaded. I wish also to ask one more question. I suppose you are aware that the whole mouth of the Thames is a net work of shoals. Supposing all the buoys removed, all the lighthouses put out, and the light-ships with their lights taken away, how long do you think it would delay you in finding the passages through those shoals, and in buoying those passages, so as to enable you to conduct this large crowded

* MM. Thiers and Dumas give some valuable information and plans about the number and description of the boats prepared for the Boulogne Army in 1804–5. One kind of boat of 86 tons was constructed to carry 29 horses and 116 men, besides provisions, &c.

fleet through that difficult navigation—a navigation which, with all the buoys, light-ships, and lighthouses in their places, is already difficult? You must assume first that our Navy has vanished altogether, or is blockaded in every port, and, then, you have to place this enormous fleet in a very narrow corner, and to land your men and horses in two very small rivers. Even supposing you have depth of water, I imagine you would find considerable difficulties in landing a large force where there are very rapid tides, with a great rise and fall of water. Those are considerations which I dare say have not escaped you.

Captain HOSEASON: Before you reply to those questions I will state a fact, that we have about a million of tons of steam-boats fit for ocean voyages belonging to the merchant marine, consequently if any attempt were made to bring over a flotilla of horse-boats, our mercantile steam fleet would be able to ride over them as cavalry would over a flock of sheep.

Captain TULLOCH: To answer your question first, I may say that I start with the assumption that the enemy would have command of the sea, because to suppose that he would attempt an invasion as long as the English fleet was on the water is out of the question.

Captain HOSEASON: I grant it; but then there would be the mercantile marine.

Captain TULLOCH: I think they would hardly dare to attempt to put to sea when the Navy could not do so. The enemy's men-of-war accompanying the transports would, with the powerful guns now in use, make very short work of any merchant steamer or steamers which attempted any offensive movement.

Captain HOSEASON: They would occupy every port in England.

Captain TULLOCH: With reference to the difficult navigation of the Thames, I consider the anchorage of the Wallett especially good, because it avoids all the shoals at the mouth of the Thames. The enemy coming from the eastward would steer as if for Harwich, and then guided by their surveying and stationary signal ships would pass between the West Rocks and the end of the East Knock, and so into the Wallett at this point above the Gunfleet Sand; once there, the great bank would be a considerable protection from any floating battery which might break the blockade of the Thames or Medway.

Sir F. NICOLSON: But the buoys are away?

Captain TULLOCH: I suppose the surveying ships of the enemy would take care to look after that, and re-buoy the channels.

Sir F. NICOLSON: I want to know how long they would be about it?

Captain TULLOCH: I will answer that question presently. Reverting to this very intricate and difficult navigation at the mouth of the Thames and the Medway, Captain Sullivan, in his evidence before the Defence Commission, was asked that very question, How long would it take you to buoy the channel, supposing all the buoys were taken away? He replied, in twenty-four hours. In the present case I avoid all that intricate navigation at the mouth of the Thames and Medway by making straight for the Wallett from the open sea; the only difficult part at all, is the passage from the Wallett into the Blackwater, and a glance at the chart will show how much easier that passage is than the one into the Medway. With regard to re-buoying the channel to the Blackwater, I put this question to the best authority I suppose in England—If all the buoys were taken away, how long would it take professional men to replace them? He said, two days.

Captain HOSEASON: "He who fights and runs away, lives to fight another day." The merchant ships would not attempt to fight, but simply to run over the horse-boats.

The CHAIRMAN: I think we must admit that very great difficulties will have to be overcome by any enemy who attempts to invade this country. It is necessary that he should first gain superiority at sea, and after overcoming that difficulty, he would have to remove other obstacles which have been referred to in the course of this discussion. He would have to replace the light-ships and buoys which will have been removed, to destroy torpedoes, and a great number of other obstacles, before he can effect a landing. But I submit that, notwithstanding these difficulties, it is a very proper subject for consideration what steps should be taken to resist an enemy. I may remark that the particular line of attack upon London, which Captain Tulloch describes as the most probable, is that which was contemplated in the

days of the Spanish Armada, and we read that it is a line which the great Napoleon (had events favoured him) intended to adopt; it is one which appears one of the most likely lines of attack to be adopted, supposing the difficulties to which I have referred, to be overcome. If I remember rightly, it is the line that Napoleon referred to in considering the advantage to him of Antwerp as being, to use his words, "a loaded pistol pointed at the heart of England." If such a line of attack were adopted, I believe, speaking generally, the means which Captain Tulloch has sketched out would be well adapted to meet it. I refer more especially to the proposed line of entrenched camp in front of Tilbury Fort, as being upon the flank of an enemy advancing from the eastward, whether by the line from the Crouch and the Blackwater, or from Harwich, where there is a very good harbour. In either case, this entrenched camp, in conjunction with the lines of fortification which were projected by the Defence Commission for the protection of the dockyard and naval arsenal at Chatham, would be the proper base for a defensive force acting upon the flank of an enemy advancing from the eastward. With regard to the particular points that Captain Tulloch proposes to occupy as permanent works, I will not express an opinion. I do not think that it is a favourable juncture to propose additional permanent works in this country. It will be better to complete what we are doing before we propose anything new. With regard to the protection of the harbours to which Captain Tulloch refers, the Crouch and the Blackwater, and the other harbours which he mentioned on the southern coast, the principle appears perfectly correct, that those small harbours should be protected to such an extent as to prevent their being seized by an invading force. Our great harbours are now nearly impregnably protected, and it would be very desirable that many of our small harbours should be protected to such an extent as to prevent their being seized by an invading force, and also to serve as *points d'appui*, from which gun-boats and other vessels, such as Captain Hoseason refers to, might act; they would be very valuable auxiliaries of defence.

Sir. F. NICOLSON: Only against horse-boats?

The CHAIRMAN: Against vessels which are not protected by an armed navy. With reference to the propositions before us this evening, I submit that the general principles are correct, namely, that our harbours should be effectively defended against occupation by an invading force, and that careful consideration should be given to the defensive positions which should be occupied in the event of invasion. It is most desirable that we should be acquainted with all this kind of information. A very different state of things exists in this country at the present time as compared with a century ago. The other day Lord de Ros, hearing that a paper on Defence against Invasion was to be read at this Institution, referred me to a document, which will be found in the appendix to one of the volumes of Lord Mahon's *History of England*, in which there is a careful sketch of an invasion of this country, prepared by the Duc de Choiseul, upon a report from an able Officer of the French Army, whom he employed. On turning to this paper shortly before coming here, I found in it a curious remark by the Officer employed by the Duc de Choiseul. After talking about the perfect ease with which an invasion can be effected by landing at Deal, and saying that he does not contemplate any opposition, he remarks, referring to our knowledge of military matters in those days, "C'est un peuple mou, qui ignore absolument l'usage des armes." It would be a great mistake to suppose such a state of things in the present day. We do not ignore the use of arms, and we should be able to give a very different account of any enemy from what was contemplated by the Minister of Louis XV. There was a remark made by one of the speakers, Mr. Mackie, to which I would refer. He spoke of a floating battery of a peculiar character for the defence of some of our harbours. He brought this proposal before us at one of the meetings of this Institution—a floating battery with rays to it, in order to render it stable. I may mention that the other day I was on board a vessel constructed upon this principle, and I formed a very favourable opinion of the principle of construction for a floating battery. Such vessels would be very useful as platforms for guns for the defence of small harbours. I speak, of course, of cases where we cannot apply the more economical means of standing works. I do not know that I

have anything further to say, than to express to Captain Tulloch our best thanks for his very interesting communication.

Sir W. CODRINGTON: Before Colonel Jervois sits down, I would ask him one question. I think he mentions that Napoleon had some idea of invading England on the north of the Thames. Am I right in thinking that the whole expedition at Boulogne was for the purpose of going the shortest distance, to cross in open boats principally?

The CHAIRMAN: That is the general idea, but in Sir Neil Campbell's book, *Napoleon at Fontainebleau and Elba*, wherein he describes certain conversations he had with Napoleon, there is one particular passage in which the Emperor stated that "if the wind admitted of it, he should prefer landing in or near the Thames, so as "to turn all the defences constructed by Mr. Pitt, rather than on the coast of "Kent."

Sir W. CODRINGTON: In the Thames?

The CHAIRMAN: In the Thames; probably he referred to a landing about Thames Haven.

Sir F. NICOLSON: Quite a different nautical operation.

The CHAIRMAN: In some respects.

Captain HOSEASON: I hope nothing has fallen from me to lead you to imagine that I am not sensible of the extreme value of land fortifications. I am only testing a given distance, the number of the enemy, and the force of shipping necessary to move them.

The CHAIRMAN: I am sure we are obliged to Captain Hoseason for bringing before us the points he has mentioned with reference to transport, and which are too often overlooked. The transport of a large force is not so easy as is often supposed; nevertheless, we are not justified in supposing that invasion is impossible. I am afraid that I have already trespassed too long on the attention of the meeting, and I move that the thanks of the meeting be voted to Captain Tulloch for the interesting lecture which he has given us.

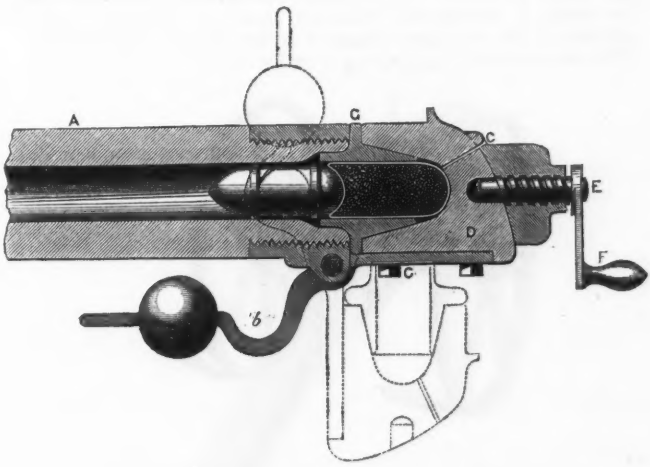
Captain TULLOCH: I beg to return thanks for the kind manner in which you have listened to my paper this evening: to the Chairman my thanks are especially due, for the support he has given me in bringing to your notice a possible line of attack, and also a scheme for the eastern defence of London, which, although new, I believe, to most Officers, is no novelty to Colonel Jervois, with whom it has been a favourite plan for some time past. I think I may justly be proud of having worked out an idea of defence which at all coincides with anything of the kind thought of by an Officer so well known in Europe as one of the greatest military Engineers this country has ever had the good fortune to possess.

MONT STORM'S BREECH-LOADING 9-POUNDER FIELD OR PINNACE GUN.

MR. CHARLES PHELPS exhibited a model of Mont Storm's breech-loading 9-pounder field or pinnace gun, which he described as follows, in Mont Storm's words:—

"The main object of this part of the invention is the application of "the gas check or valve adapted to my improved breech-loading fire-"arms. This gas valve consists of a loose tubular lining which fits "into the barrel of the weapon, and covers the junction between the "barrel proper and the breech-piece, and being capable of an endway

" movement by reason of the expansive force of the ignited powder
" will completely seal the joint between the breech and barrel.

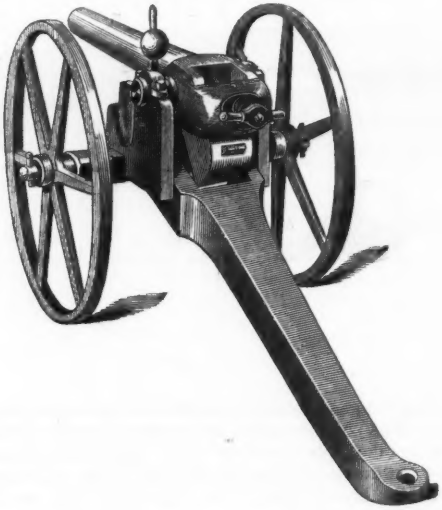


" In applying the gas check or valve to breech-loading cannon, I pro-
" vide the barrel (A) of the cannon at its inner or rear end with a screw
" thread, which takes into a hollow screw tapped in the breech frame.
" This hollow screw or ring carries the trunnions and forms the for-
" ward end of the breech frame. On the under side of the trunnion
" ring two lugs are formed to receive an axle (*a*) which passes through
" a similar lug formed on a hinge piece (C) attached to the moveable
" breech (D). Keyed to this axle is a weighted lever (*b*) which serves
" to counter-balance the breech, and thus facilitate the working of the
" gun. The rear end of the breech frame is tapped to receive a quick
" screw (E) which enters a hole bored in the rear end of the breech,
" for the purpose of securing the breech in position when the cannon
" has been charged. A recess is made in the breech-chamber to
" receive the gas check or valve (G), the front end of which projects
" into the barrel.

" The vent (C) for firing the cannon I prefer to carry through the
" breech frame to give access for priming, so that if by any chance it is
" attempted to fire the charge before the breech is brought 'home,' or
" to its proper position, the 'vent' will be closed by the hole in the
" breech frame not being in coincidence with the breech. To charge
" the cannon I withdraw the screw bolt, when the breech will fall out
" of line, and the gas valve will come away with it. In the breech-
" chamber, contracted by the insertion of the valve which forms a
" lining thereto, the cartridge is placed and the shot or shell is inserted

"in the barrel of the cannon through the now open rear end; I then "by means of the weighted lever before mentioned raise the breech "into position, and secure it there by the screw bolt; the cannon is "then ready for firing. For adjusting the cannon to the proper angle "for firing, I provide the elevating screw or analogous device in "advance of the trunnions instead of in rear thereof as heretofore."

This arm requires no special ammunition or fuze.



Evening Meeting.

Monday, June 6, 1870.

W. STIRLING LACON, Esq., in the Chair.

NAME of MEMBER who joined the Institution between the 30th May and 6th June, 1870.

ANNUAL.

Clanchy, Henry F., Lieut. R.N. 1*l.*

THE AMOUNT OF ADVANTAGE WHICH THE NEW ARMS OF PRECISION GIVE TO THE DEFENCE OVER THE ATTACK.

By Captain H. Schaw, R.E., Professor of Fortification and Artillery, Staff College, Sandhurst.

The title of the paper which I am about to read, and which I have drawn up at the request of the Council of this Institution, implies that the Defence has obtained a certain amount of advantage, as compared with the Attack, in consequence of recent improvements in fire-arms. The fact of my having undertaken to read this paper, moreover, shows that I individually entertain this view. But it is undoubtedly a question which admits of discussion, and even supposing the case for the defence to be shown to be stronger than it formerly was, the amount of advantage which it may have obtained, remains to be decided.

When I agreed to draw up this paper, it had escaped my memory that I had entered somewhat at length into the subject in a paper which I had the honour of reading at this Institution in May, 1866, on "The "Present State of the Question of Fortification." But so many improvements have been introduced into fire-arms in the four years which have since elapsed, that I am in hopes a resumed discussion of the subject will not be without its interest.

Our great system of Fortification for National Defence is now approaching completion, and our Army system is undergoing a change with a view of securing an efficient reserve to augment our standing Army in time of war, and, in combination with our Militia and Volunteers, to ensure a sufficient force for the defence of our interests on shore, both at home and abroad.

The question now before us in its home aspect is this—Has the value of our defensive Army and of our fortifications been enhanced, or has it been diminished by recent improvements in arms of precision? And first, let us notice what these improvements are, taking the three

epochs 1850, 1860, and 1870; 1850 as representing the period of smooth-bores; 1860 as the period of rifled muzzle-loading small arms, and of rifled artillery of comparatively small calibres; and 1870 as representing the state of European armaments, either actually existing or in course of introduction:—

	1850.	1860.	1870.
Small Arms.			
Effective range (yards)	200	600 to 800	600 to 800
Rapidity of fire (rounds per minute)	2	2	6 to 8
Mitrailleurs.			
Range	Nil.	Nil.	1,000
Rapidity of fire	..	..	12
Field Artillery.			
Effective range—case	300	300	300
,, shot and shell	1,000	500 to 3,000	500 to 3,000
Rapidity of fire	2½	2½	2½
Garrison, Naval, and Siege Artillery.			
Effective range for horizontal fire—case	600	600	600
,, shot and shell	600 to 1,000	1,000 to 3,000	1,000 to 3,000
Do. for bombardments	4,000 (mortars)	4 or 5 miles.	4 or 5 miles.
Required to give cover—masonry	6 or 8 feet resisted for a long time.	Easily destroyed.	Very easily destroyed.
,, earth	18 feet.	25 feet.	45 feet.
,, iron	Not used.	3½ to 5 inches.	12 to 14 inches.

In order to discuss the effects which these improvements in fire-arms have produced, let us begin by considering two armies manœuvring in an open country; one seeking to attack, the other acting on the defensive. In such a case, I conceive that the force receiving the attack will have a greater advantage than formerly, or perhaps more correctly, it will act under less disadvantageous circumstances than formerly; for it may be taken as a well-established maxim, that the attacking force has not only the moral advantage resulting from the consciousness (true or false) of superiority implied by the fact of attacking; but also the tactical advantage of choice of time, place, and mode of attack; but the force receiving the attack will have the advantage, probably, of keeping the assailants under artillery fire, more or less destructive, from 3,000 yards to 1,000 or 800 yards—then mitrailleurs will play their part—and finally, when the enemy's skirmishers have driven both guns and mitrailleurs to the rear, the last 300 yards of the advance will have to be conducted over ground swept by the fire of infantry, kneeling or lying down, and so presenting a

small mark, and steadily firing at the rate of 6 to 8 rounds a minute, which represents from 10 to 20 rounds per man. The destruction which must have been caused by this amount of fire, and more especially during the last two or three minutes of the advance of the assailants, is so very much greater than formerly was the case, that if there be anything approaching to equality in the original numbers and in the *morale* of the troops engaged, a bayonet charge made by the defenders, when their assailants have nearly closed with them, ought to complete the demoralization of the attacking force.

Should the defenders have time to protect themselves by means of shelter-trenches and rifle-pits, from the fire of the attacking force, their advantage will be immensely increased, for not only will they be stationary and firing at known ranges at the enemy who is marching, and therefore less able to take steady aim, and who has to judge his distances, but also the defenders will be practically sheltered from the enemy's fire, both of artillery and small arms.

Should the country be wooded, and the necessary short time be accorded to the defenders to entrench themselves, their position, if well chosen and well defended, may be considered practically impregnable against a front attack, for in addition to their shelter trench, they will have felled a belt of trees along their front, giving a range to their rifles and interposing a most formidable obstacle, of the rough abattis so formed, between them and the enemy. Such a position must be looked upon, however, as purely defensive, for the obstacle which impedes the enemy's attack, precludes the defenders also from following up their victory, when the attacking force falls back in disorder, overwhelmed by their rapid fire. As regards the time required for the construction of such an abattis and shelter trench, Colonel Smyth, R.A., records in the Proceedings of the R. A. Institution, Vol. IV., that he saw a log breastwork formed by a brigade of the Federal Army along its whole front in forty minutes—the tools used being one axe and one shovel to every ten men, in addition to the ordinary pioneers' tools.

In an experimental essay made at the Staff College last year in the pine forest which covers a large portion of the College estate, 12 files of the detachment of Royal Engineers entrenched themselves in an hour, the rear rank only working, the front rank being distributed as skirmishers to cover the working party. At the end of the hour a trench sufficient to cover both ranks and supernumeraries was formed, and the trees felled and formed into an irregular abattis for about 90 yards in front of the trench. The tools used were six axes, three shovels, and three pickaxes for the 24 men. It was found that *cover* could be obtained more quickly by digging a trench and throwing up the earth in front, than by felling trees and using the logs to form a breastwork; but that the obstacle formed by the felled trees in front, made troops, so entrenched, practically unassailable in front.

The result of the experience gained in the late American War, which was carried on chiefly in a country covered with immense forests, proved conclusively the value of these rapidly formed entrenchments, almost invariably made by the side acting on the defen-

sive. Towards the end of the war it came to be so well understood, that front attacks on entrenched positions were not attempted; but the troops holding the position were dislodged by turning their position and threatening their communications. This result, it must be remembered, was obtained before breech-loading small arms had been largely introduced, and without the aid which the defenders might now draw from the use of mitrailleurs or Gattling guns.

Supposing an entrenched position in a forest to have been turned, and the contending forces to be engaged amongst the trees on equal terms, except that the defenders are holding ground and the assailants endeavouring to gain it, the balance then seems to turn in favour of the assailants. Long range arms of precision almost entirely lose their value, and the rapidity of fire of the breech-loading small arm aids the assailants as much as the defenders at short ranges, while the moral and tactical advantages remain with the former.

The comparative valuelessness of the rifled field-gun in forest warfare became so evident to the Americans during their long struggle, that in the reorganisation of the army at the close of the war, General Grant determined to retain in the service a large proportion of the smooth-bore guns which, with other patterns of field guns, had been tried during the war. This gun was the bronze 12-pounder shell gun, or Napoleon gun, as it is called after its illustrious inventor, the present Emperor of the French, who had introduced it to take the place of the old combined batteries of guns and howitzers; but who abandoned it when the progress of small arms made a corresponding advance in the range and accuracy of artillery necessary in ordinarily open country.

In cultivated countries such as our own, or considerable portions of Europe, where a battle-field can scarcely be found in which hedge rows or fences of some kind, copses and woods, villages, and houses, streams, and hollow roads do not occur, in addition to the usual undulations of ground which may give cover to troops, it becomes interesting again to consider the comparative gain to the attack or the defence due to the improvements in fire-arms.

Fences and enclosures are for the most part more advantageous to the defence than to the attack; but in a flat country they protect the advance of an enemy considerably and screen his movements from the defenders, so that the tactical advantages peculiar to the attack are enhanced by them, and the value of the destructive fire of artillery and mitrailleurs is in great measure lost to the defenders. Against the first advantage to the enemy, the defenders however can oppose the use of balloons, and to balance the latter they have the rapid fire of small arms, from infantry lining fences, directed upon the enemy's advance over the last fields to the attack, and of their artillery and mitrailleurs enfilading roads, &c. In such a country the gain therefore seems to be still to the defenders, if they are as well drilled and as well commanded as the assailants. Their tactics should be to wear out the enemy by a gradual retreat, covered by skirmishers occupying successive lines of fences, so selected and improved, as to ensure the retreat of each successive front line through re-entering

angles in the supporting line, and to crush the head of any pursuing body of the enemy by a rapid converging fire should they attempt to follow up the fugitives closely, and by the action of cavalry held in reserve near the supporting line. We learn that similar tactics were frequently used during the late American War. Small trenches were formed in several lines supporting one another, and the defenders of the front line running back through the forest occupied the second, when driven by superior force from the first, and so on.

Small woods or copses, without any preparation, are valuable to the troops who occupy the edge of the wood, as they are screened from view and covered in a great measure from the fire of small arms or mitrailleurs. Artillery fire is dangerous to troops occupying the skirt of a wood, but if the trees are of good size a comparatively narrow belt is sufficient to expend the power of the projectiles of field artillery, whether smooth-bore or rifled. Hence woods or copses are more useful than hitherto to the defence. Their cover is as effective as formerly, and the stream of fire which the defenders may cause to issue from them is more rapid and deadly.

Streams are passive obstacles, which give no cover; if they are so placed as to check the advance of an attacking force when under fire, they have a greater value than hitherto, owing to the greater precision of modern fire-arms; but artillery fire has comparatively little effect upon troops crossing marshy ground, such as generally is found near streams. Every projectile which falls short sinks into the ground, and produces no effect.

Houses and villages give an immense advantage to modern infantry when they cannot be attacked by the distant fire of artillery—for artillery fire is now more effective than formerly against buildings, inasmuch as the penetration of rifled elongated projectiles is greater into brick or stone walls, and the bursting charges of shells are larger, and consequently the houses are more liable to be set on fire.

The case of a large village, however, or small town, is very similar to that of a copse, or small wood. Skirmishers can hold the outskirts, notwithstanding the fire of artillery, which will do them but little injury, while the reserves will be very much sheltered by the houses, if retired to the centre or rear of the village, as the belt of houses in front of them will stop most of the projectiles.

Unless the village be constructed of wood, or the roofs be of thatch, it may take a vast amount of artillery fire to burn it down, or make it untenable. If there be a wood or rising ground in front of the village, which would screen it from distant artillery fire, it becomes a tactical point of great value, and may be held by the defenders for a long time against greatly superior forces.

In the Prussian official account of the campaign of 1866, there are many records of sanguinary conflicts between the Prussians and Austrians in and around villages, railway stations, and farmsteads, and although the one-sided nature of the struggle, owing to the superior weapon with which the Prussian infantry were armed, makes it difficult to draw absolute conclusions; yet the general result seems to show that villages, or clusters of houses, occupied by infantry armed

with breech-loaders, and well supplied with ammunition, are almost unassailable by infantry; but that a combined attack by artillery and infantry is likely to be successful, as it formerly was. In fact villages occupy at least as important a position in defensive operations as formerly, for while the action of artillery upon them has become greater, the effect of the infantry fire from them has increased in probably a greater ratio still.

Isolated houses, when exposed to modern artillery fire, must evidently be untenable. This probably was the case in the days of smooth-bore artillery, unless the buildings were of very massive structure. Indeed it has been a subject of astonishment to me, and probably to many others, why, at the battle of Waterloo, the buildings of La Haye Sainte were not attacked by the powerful artillery which the French had massed on the opposite hill, before they were assaulted by infantry. There were no trees to mask the buildings, as there were then at Hougomont, and Napoleon knew full well the value of artillery to prepare the way for his infantry. The old proverb, "Quem Deus vult perdere prius dementat," is probably the only explanation that can be offered.

In the campaign in Bohemia, in 1866, the Austrians had in some cases prepared large buildings for defence, but being exposed to artillery fire and to the attack of infantry armed with the needle gun, these defences did not prove of much value.

Reviewing, then, the whole question of the action of the improved arms in respect of the attack and defence of positions, whether prepared beforehand by rapidly constructed entrenchments or not, and in whatever description of country, we may fairly conclude that, except in forests, where the defenders have had no time to entrench themselves, or have neglected to do so, in a flat country intersected by fences when the assailants are better drilled and handled than the defenders, or in the case of buildings attacked by artillery and infantry in combination, the defence has decidedly gained by the introduction of improved fire-arms. In fact it is almost self-evident, that whenever troops advancing to attack are exposed to the defenders' fire, while the defenders are in any degree covered from fire, either by their recumbent position, the uncertainty as to range of the assailants, or natural or artificial breastworks; the increased range and precision and destructive effect of artillery fire, the introduction of mitrailleurs, and the increased range, accuracy, penetration, and above all, rapidity of fire at point blank range, of the infantry arm, give to the defenders a power of destroying their assailants before they can come to close quarters that they have never possessed hitherto, and consequently very greatly increase the chances of success on the side of the defenders.

One peculiar result which has followed upon the introduction of rifled artillery, and which can hardly be said to give an advantage to the attack or to the defence, is the difficulty of obtaining cover for the reserves by the folds of the ground in an open undulating country. The Austrian reserves are said to have suffered much from the fire of the French rifled guns at the battle of Solferino, and the late experiments at Dartmoor showed that the curved fire of modern artillery

would produce terrible ravages in reserves placed on the reverse slope of a hill, the summit of which was occupied by the first line. The battle field of Waterloo would not give the same advantage now to troops posted as the English army was, that it did when that battle was fought, for the curved fire of modern artillery would now reach the reserves in the hollow, where they were skilfully placed by the Duke of Wellington, and in which they were comparatively safe in 1815. Perhaps we may say that the defenders, knowing what to expect, may counteract in great measure this effect of modern artillery fire, by preparing shelter trenches for their reserves, while the assailants cannot have the same advantage, and that in this case also the balance is still rather in favour of the defence.

We may pass on then from the case of two armies manœuvring in the field, of which one, being the weaker, is acting on the defensive, to the next step in the defence, when, of the two contending forces, one is so much weaker than the other that it has recourse to regular field fortifications, and the contest becomes one of the attack and defence of an entrenched position, such for example as that constructed by the Danes at Düppel, or the celebrated lines of Torres Vedras at Lisbon. To which side now inclines the balance of advantage derived from the recent improvements in fire-arms?

Should the attacking force possess a numerous and powerful artillery capable of producing a decided effect upon earth-works, as was the case in the Prussian attack on the Düppel entrenchments, and should it happen, moreover, as in that case, that the position chosen by the defenders is so injudiciously selected that an enfilade, or converging fire of artillery can be brought to bear upon it; then it appears probable that the advantage will be with the attack. But it will more generally happen that such fortified positions will be armed with a more numerous artillery, and of heavier calibres than the assailants can bring to the attack, unless they wait for their siege train, and if the officers on whom the responsibility of selecting and fortifying the position falls, are equal to the emergency (as in these days of army education they certainly ought to be), no such mistake will be made as to give the attacking force the advantage of an enfilading or converging fire of artillery, covering the approach of his assaulting columns, and keeping down the fire from the works until the supreme moment for the final assault has arrived. On the contrary, the works, if well designed, should give such security to their defenders that even after a heavy cannonade the assailants, if attacking by day, ought to find themselves under fire of securely posted artillery for the maximum distance which the features of the ground will allow, and this fire ought to increase in intensity as they approach, and be supplemented by the terrible aid of mitrailleurs, and, finally, of the infantry manning the works, under whose close and rapid fire, and probably also an enfilading fire of artillery and mitrailleurs, they would have to overcome the obstacles placed outside the line of works. Such an attack could have but one result, and no one would probably have the temerity to attempt it after the numerous failures which occurred during the late American war.

Surprises and night attacks may now be more frequently attempted than formerly, in order to avoid the certain destruction produced by modern fire-arms in a day attack on an entrenched position; but such attempts have always been hazardous, generally desperate, and as the struggle must be at close quarters, the chances of success do not appear to be much influenced by improvements in fire-arms, except in the case of a failure, and a retreat when day has begun to dawn, then the fire from the works would be more redoubtable than formerly, and the assailant's loss proportionately heavier.

In connection with this branch of the subject, two points merit notice. The first is as regards the mode of mounting the artillery for the defence of field forts and redoubts, when they would be in the position of garrison artillery, and could not be withdrawn. My lecture delivered here in 1866, before alluded to, mentioned the difficulties which then existed with regard to embrasures and barbettes, the only methods then known for serving artillery in fortifications, and I expressed the hope that some means would soon be discovered of raising guns to fire over parapets, and lowering them again to load, like small arms. This desirable result has been achieved by Captain Moncrieff's most valuable invention, but I regret that hitherto his discovery has been applied only to very heavy guns for coast defences. No doubt this application of the principle is the most difficult, and success here proves undeniably its value, but I am not at all convinced that it is the most useful application. Lighter guns on simpler carriages (perhaps, as the inventor has suggested, on their ordinary travelling carriages modified so as to suit his system) will be required in great numbers to arm the land fronts of our permanent natural defences, and the field works which, in case of war, would have to be thrown up to complete the chain of forts; and counterpoise carriages suitable for these purposes have not yet been produced. The old embrasure may, I think, still be found most useful in the flanks of works, because the lateral range there required, is generally small; the position is peculiarly unsuited to the Moncrieff system, being exposed to enfilade fire; and the ordinary carriage is most convenient for facilitating the movement of guns by hand inside a work, so as to concentrate their fire on either side as may be required; also the embrasures in the flanks would not ordinarily be exposed to the view or artillery-fire of the enemy when at a distance from the works. But for salient or shoulder angles, and on front faces, the Moncrieff system is immensely superior to either embrasures or barbettes, or even to the continental plan of high carriages, raising the guns sufficiently to fire over parapets $4\frac{1}{2}$ feet high above their platforms. The continental system has the advantage of simplicity in the carriages, and of the whole of the parapet being suited either to artillery or musketry defence; but it has the great disadvantage of exposing the guns and gunners much more than in the Moncrieff system, and consequently of giving a greater chance for the attacking artillery to destroy the artillery of the defence by long-range firing.

The other point I would refer to in connection with field fortifications, is the best use to make of mitrailleurs in such positions. In

fortifying irregular ground it often happens that a long spur from a hill on which a work is to be placed, juts out towards the enemy; it is too narrow to be occupied, and the only thing to be done is to retire the line at this part, so as to oblige an enemy, who can mount the slopes at the end of the spur unseen, to pass over as long a distance as possible under fire from the works after he has gained the summit. In such a case a mitrailleur in the face which defends the spur would be very useful, but the difficulty arises how to mount it—an embrasure or a barbette would expose it to destruction by the enemy's artillery, and a Moncrieff counterpoise carriage is unsuitable, owing to the small tendency to recoil. Some other system of mounting mitrailleurs so as to fire over parapets, and to allow of their being lowered out of sight when not required, must be adopted, and probably a modification of the counterpoise system will be found to answer the purpose. The flank defence of the ditches of field-works may be most effectively performed by mitrailleurs in timber kaponiers whenever the ditches are so wide as to make them obstacles of sufficient importance to be worth flanking, and if they are deep enough, or a glacis can be raised high enough to protect the kaponiers from the enemy's artillery. The Montigny mitrailleur appears, however, to have one defect as a machine for defending a ditch, the bullets are not sufficiently heavy to break ladders or light bridges used by the enemy for crossing it.

In a flank enfilading a line of abattis in front of a collateral face, one mitrailleur would be far better than two or three field-guns ordinarily allotted to such a position. The rapidity of fire and small dispersion of the bullets of the mitrailleur make it more destructive to an enemy than the artillery firing case, while the bullets themselves would not injure the obstacle. An ordinary embrasure with a mantlet would answer very well for serving the mitrailleur, and the flank need only be long enough for the embrasure, say 10 yards, and the length of the line flanked might probably be 600 or 800 yards in a level country. An equivalent infantry fire would require a flank about 50 yards long, allowing that one mitrailleur is equal to 100 infantry. This flank would be very open to enfilade, and would require several traverses to protect the men, while the mitrailleur would be nestled safely in the angle, and covered by the front parapet.

We may conclude, then, I think, that if field fortifications are well designed and provided with bomb-proofs, and with artillery and mitrailleurs mounted on suitable carriages, the defence has gained rather than lost. It is true that greater skill in designing, and more labour and materials for the construction of the works are necessary than heretofore, but if these be available, and in no country ought they to be more readily obtained than in our own, the assailants will not find their task in any way lessened should they attempt an artillery attack. However much the range, precision, and power of field artillery may have increased, it is certain that existing rifled *field* guns are not very effective against earth-works, and even should rifled howitzers be introduced throwing heavier shells than the 12-pounder, it will not be difficult to make field-works which shall secure their garrisons and their guns in a great measure from the destructive effects of their fire, while

the assailants will be exposed to the full effects of improved fire of all sorts. Regular siege works will, therefore, become necessary for the reduction of good field works, unless an assault at night or a surprise be attempted.

We may now take the final step upwards in the degrees of defensive works, and compare the position of regular fortifications in the year 1870 with that which they held in 1850 and 1860. I will not occupy your time by going again in detail over the arguments which I put forward in 1866. I endeavoured then to show that the gain had been decidedly for the defence over the attack, should the former be skilfully conducted in well-constructed works. The importance of covering all masonry, not only from the view of the enemy, but also from the possibility of being reached by the curved fire of his artillery, at ranges as great even as two or three miles, was noticed; and also the necessity of improving our manner of mounting artillery, and of securing a sufficient amount of bomb-proof cover for the troops off duty, and safe positions, indestructible by the enemy's distant artillery fire (as in properly-placed casemated kaponiers) for the guns flanking the ditches. In default of these precautions—*e.g.*, should the attack be conducted against an old-fashioned fortress by an army provided with modern artillery—there can be no doubt that the attack would have a much greater advantage than formerly.

The siege of Borgo Forte by the Italians, in 1866, is an example of the advantage which the besiegers now possess, under favourable circumstances, of constructing their first batteries without loss or inconvenience from the fire of the place, or from sorties. Rifled siege-guns being more effective at 1,500 or 2,000 yards than the old smooth-bores were at 600 yards' range, an immense choice of positions for batteries is given to the besiegers, who in most cases can conceal them from the garrison until they are ready to open fire. Such was the case at Borgo Forte. The works of the Austrians consisted of four forts, forming a quadrilateral, and intended as a double *tête du pont* to secure the passage of the Po to an Austrian army operating on either bank. Three of the forts were on the left bank, and one—"Fort Mottegiana"—was on the right bank. This latter was the special object of the Italian attack; but to ensure success in this attack it was necessary that the artillery of two of the remaining forts, which were near the left bank of the river, should be silenced, as they supported Fort Mottegiana by their fire. A rivulet, which partially encircled Fort Mottegiana, at a distance of from 1,500 to 2,000 yards from it, and which was bordered by strong dykes, together with similar dykes bordering the river Po, formed natural parallels, and partially-formed batteries, for the Italians, while the long grass, and in one case an orchard, so concealed their operations, that after seven days' labour they opened fire from 74 siege-guns and some field-pieces, without having been in any way molested by the garrison, who seem to have been quite ignorant of the besieger's operations up to this time. The distances of the Italian batteries from the forts thus attacked, varied from 1,500 to over 3,000 yards, and at these ranges they appear to have been very effective. Nearly 50 guns concentrated their fire on

Fort Mottegiana, and in a few hours silenced it completely. The shells which passed over the crest of the parapet, fell rapidly in their curved trajectory at those long ranges, and struck the defensible barrack and loopholed wall which were at the gorge of the work. These they partially demolished, and the quantity of fragments from the walls found scattered over the interior of the fort after the Italians entered it, testified to the power of the curved fire of modern artillery against masonry. The "ever back flying splinters," as the Germans well describe them, must be particularly demoralising to a garrison subjected to their influence. The Italian fire was kept up for about 24 hours, when two great explosions gave notice that the Austrians had abandoned their works, and had destroyed the two forts on the left bank by exploding their magazines.

In an interesting discussion on this siege, or rather artillery attack, which took place at one of the occasional meetings of the Corps of Royal Engineers in June, 1867, it was remarked by Sir John Burgoyne, that from the point of view simply of attack and defence of fortresses, there was not the slightest reason why the Austrians should have abandoned their works; their parapets were still efficient, and the ditches, escarps, counterscarps, and flanking kaponiers were quite perfect. The artillery of the attack had asserted its superiority; but the siege-works proper had hardly been commenced. Regular approaches would have been required to get up to the fort, and skilfully-disposed counter-approaches and batteries on the left bank, together with the fire of small arms and occasionally of guns from the fort attacked, would have made this operation no less difficult and dangerous than hitherto; while the distance to be passed over was much greater than would have been required in former days; and when the approaches drew near to the fort, and the fire of the besieger's distant batteries was masked by their own works, the construction of the later works and breaching-batteries would be more difficult than ever, owing to the greater power of modern small arms. The success of the actual attack must be attributed mainly to strategic causes. The Austrian Emperor had determined to give up his footing on Italian soil. This *tête du pont* then, of which the sole object was to secure the passage of the Po, had become useless, and it was therefore needless to waste lives in its defence. But it must also be noted, that the assemblage of works forming this quadrilateral was not sufficient to secure the desired end. From the moment that an enemy's batteries were established in secure positions commanding the bridges, and the approaches to them, the works had become useless, for they no longer secured the passage of the river. This shows, incidentally, what an extremely difficult problem it has now become to construct a good *tête du pont*. Before the introduction of rifled artillery, this *tête du pont* would probably have answered its purpose very fairly, for the fire from its heavy guns would have kept an enemy's artillery from being placed anywhere between Fort Mottegiana and the dykes; and under cover of the dykes, smooth-bore guns would have been too far from the bridges to injure them, or incommode seriously troops passing over. Three or four additional forts on the right bank of the

river would be necessary now to make an efficient *tête du pont* in this position.

To summarize the state of the question as regards the attack and defence of inland fortresses, we may conclude that the improvements in fire-arms have increased the difficulties on both sides. Fortresses must now cover much more ground than formerly, and in construction and in armament, they must be much more expensive, and, as a necessary consequence, there must be fewer of them. In their attack the operations must be commenced at a much greater distance, and the batteries and magazines must be much more strongly constructed than formerly. The besieger's means of destruction are more efficient than they used to be, but the skill of the Engineer has fully kept pace with that of the Artillerist, and the defences are now much more difficult to destroy than of old. More men, more *materiél*, more skill, more time must be devoted, both to the construction of a fortress and the taking of it, than formerly. Eventually, no doubt, the superior numbers and means of the besiegers must prevail, as always has been the case; but his task is immensely more difficult than it used to be, and it must be more tedious and expensive; and this is clearly a gain for the defence. Fortresses can be made at leisure in time of peace, and their object is generally to gain time This object they will fulfil more completely than heretofore, while the necessity for increasing the size and diminishing the number of fortresses which has resulted from improvements in fire-arms, favours the concentration of forces which all able strategists have recommended for years past. The First Napoleon's well-known saying, puts it very forcibly: "Pretendez vous défendre une frontière par un "cordon? vous êtes faible partout, car enfin tout ce qui est humain, "bons officiers, bons généraux, tout cela n'est pas infini, et si vous "êtes obligé de disséminer partout vous n'êtes fort nul part."

We have now worked up to the point which is certainly of the greatest importance to us as a nation, viz., coast and harbour defences, for it must be evident to any moderately thoughtful person that, however necessary it may be to provide against those unworthy invasion panics which used to recur periodically, by keeping up to a sufficient strength our land forces, and rendering ourselves secure against any sudden attack, yet it is to our Navy that we must trust for the real defence of England. It is in vain to hide from ourselves, what must be plain to foreign nations, that a prolonged struggle with an invader on our own shores is hopeless; for its possible occurrence implies the loss of our naval supremacy, and the command of the seas by the invaders; and this again implies the destruction of our commerce, and manufacturing interests, and on these would speedily follow such want and misery in this country,—which does not produce food enough for the consumption of its inhabitants,—and such discontent amongst the millions of unemployed workpeople, that a prolonged contest with a powerful invader would be out of the question. These facts have led to the careful defence of our great Naval Arsenals, in order that our Navy may have secure harbours of refuge, and that our power of refitting, renewing, and increasing our Navy may not be injured by any sudden attack, either by sea, or by sea and land combined. We

have to consider how the balance of advantages turns with reference to these defences. The Attack has gained this immense advantage over the Defence, that, with modern artillery, to see a Naval Arsenal is pretty nearly equivalent to destroying it. The range and power of artillery is so increased, that any considerable area may be efficiently bombarded from a distance of four or five miles, if it can be clearly seen. Hence the distance to which the defences must be carried in such cases as the defence of dockyards, is immensely increased, and with it the difficulty of obtaining men, guns, &c., sufficient for such extensive positions. The gain, however, is not all on the side of the attack; with long ranges came also shells, so destructive to vessels, that iron-plating became necessary; and then began the race between guns and armour-plates, still unfinished, but which must undoubtedly end in favour of the defence, for there is a limit to the weight of armour-plates which can be carried by a floating battery, but none to that which can be applied to a shore battery. Torpedoes also may fairly be classed amongst the modern improvements in fire-arms, which tell almost entirely for the defence, and greatly increase the difficulty and danger of the attack.

One point in connection with the defence of harbours, &c., has been much discussed of late, viz., whether in the defence of a channel it is best to have a number of batteries so arranged, that an enemy's vessel must pass them in succession, one after another taking up the fire; or whether it is better to accumulate all the defences of guns, torpedoes, and passive obstructions at one point in the channel. If one plan or the other must be adopted, there can be little doubt that the latter is the most effective, as the experience gained in the late American war has demonstrated beyond contradiction, that steam-ships may pass up a channel at speed, running the gauntlet past batteries without any very great risk; but that shore batteries, if combined with obstacles and torpedoes, cannot be passed. Whenever both systems can be united in the defence of a channel, it may be pronounced impassable by the strongest fleet, without the co-operation of troops on shore.

The question whether a naval attack on shore batteries may now be undertaken with reasonable hope of success, is one of much interest. Before the introduction of rifled artillery it has happened, on at least two occasions, that a frigate has been beaten off by one gun on a tower. The unstable platform of the ship combined with the imperfect shooting of her guns, and their small effect at long ranges on masonry, made her fire harmless to the tower, while the one long range gun there, on its stable platform, hulled the ship frequently. Our naval attack on the granite forts at Sebastopol showed that, at that time, the shore batteries had decidedly the advantage. But during the late American war, the results produced by a combined attack of iron-clads and wooden ships, armed with powerful guns, were often decisive on shore batteries, whether of earth, masonry, or even imperfectly constructed with iron.

The naval attack on Fort Fisher, at the mouth of Wilmington harbour, may be cited as a remarkable example of a successful naval attack on strong earthworks; but it must be remembered that the fort

was unwisely constructed in such a position that ships could converge their fire upon it from a large arc of a circle and enfilade, or take in reverse its faces, and that its guns were chiefly mounted *en barbette*, but slightly raised above the water, and that they were not powerful enough to penetrate the ironclads.

In many of the naval operations conducted by the Federals to open up the River Mississippi, their ironclads succeeded in overcoming the fire of shore batteries, even when the guns were skilfully dispersed in small batteries, or gun-pits, and in some cases 50 or 100 feet above the water, but firing *en barbette*.

In all these cases, however, we must bear in mind that the Federals had a great superiority in the power of their guns and the efficiency of their iron plates.

Properly constructed casemated forts, either of iron alone, or of granite and iron combined, and armed with powerful guns, have not yet been tried against ironclad ships; but there can be little doubt that in such works, the old balance of power between guns afloat and guns on shore has now been in some degree re-established, and that earthworks even, when situated on high bluffs, with heavy guns on Moncrieff carriages, may successfully cope with heavy guns afloat; the great advantage of their plunging fire on the decks of the ships being taken into account. But in the construction of works on shore, the example of Fort Fisher must be kept in mind, and the fault there committed by the Confederate engineers, avoided, great care must be taken in deciding on the position of shore batteries, that a large fleet may not be able to form on a wide arc of a circle, and moving slowly under steam, so as to render the task of hitting them more difficult, to throw a converging fire upon the works on shore. Under such conditions, it is probable that the Navy would have the best of the engagement.

I have now endeavoured to follow the question before us through the various cases of attack and defence, and I think that it will be admitted generally that if the facts and arguments I have brought forward are true and sound, the balance of advantage has, upon the whole, turned in favour of the defence, with this proviso, that the defenders are fairly equal to the assailants in courage, in their weapons and *materiél*, and in their skill and education.

In conclusion I would make one remark with reference to our national defences, which I hope may be thought worthy of consideration. We have nearly completed the fortifications which form the basis of our system of defence, and the fortresses we have constructed are necessarily so extensive, that the question of garrisons becomes very difficult. It is clear that for this purpose our Volunteers must be largely employed, and it is a mode of employing them which would be the most advantageous, for we may confidently believe that no troops in the world would be superior to them in the points of courage, endurance, and good shooting, the main essentials for the troops garrisoning a fortress; while we must also feel that it would be unfair to them, and probably disastrous to us as a nation, were they, with their imperfect training and organization, pitted against picked foreign troops in the open country: the superior manœuvring powers of the regular troops

would, in all human probability, ensure them a victory over our Volunteers, however brave and devoted.

Would it not, then, be a very practical and useful exercise for our Volunteers, on some of those occasions when, as on Easter Monday, they meet in large numbers together, that they should garrison a portion of those works which, in case their services were ever unfortunately required for the national defence, must evidently be entrusted to them?

The infantry and artillery might be divided into three divisions, of which the first would garrison some of the advanced forts, say, for instance, at Portsmouth; the second, the inner line, and the third, in combination, if possible, with some regular troops, would act in the open between the forts; while the engineers would be employed in tracing those auxiliary field-works for the support of the last-named division which would be necessary in time of war. The usual march past might of course be carried out before or after the main labour of the day.

Mr. Edwin Chadwick, C.B.: I have paid special attention to the military testimony on the question dealt with in the paper read, which involves a very large politico-economical question as to the relative economy of defensive, as compared with offensive armies, which weigh so heavily on European nations. And as far as I have consulted that military testimony, which has been of a high order, I believe the conclusions from it are more decisive as to the gain on the side of the defence, than has been stated in the paper read to-night. It is some eight or ten years ago since I discussed the subject with the late Captain Fowke, of the Royal Engineers, whose mastery of his profession, and clear comprehensive view of it, were declared by high military authorities; and his general conclusion was, that the new arms of precision, even in their then state, while they gave one to offence, gave two to defence. But since his time science has made large strides, and if the position taken by Captain Fowke were sound then, it may now be established in further evidence than that contained in the paper, that whilst science gives one to offence, it gives at least three to defence. I believe that I was the means of recommending Mr. Whitworth for consultation, as the first mechanic of the time, for the improvement of the manufacture of small arms; and I have watched the progress of the manufacture of large as well as small arms with interest, in its economical aspect. When he had achieved his smallest rifled gun, which has a longer range than the heaviest old field-piece in the service, his 3-pr. having a point blank range of a mile, and at 20 degrees a range of 5,500 metres, or more than three miles, as against the best French 12-pounder field gun, which had only a range of 3,500 metres, and at 35 degrees of elevation of a range of five miles with the Whitworth shell—I sent an account of this implement to the late General Shaw Kennedy, of whose repute as a tactician I need not speak; and I asked him what would have been the event if we had had a sufficient number of those guns at Waterloo? The General's answer was, that as against that gun, that battle could not have been fought, because Bonaparte's front line was half a mile off, and his reserves were a mile off;—but as against such a weapon, he must have had them more than three miles off, and he could not have brought them up over that field under the fire of that weapon. Nor is it easy to see how he could have advanced in the open, if he had led them himself, against guns so easily put under cover, and with powers of converging fires, of shell as well as shot, from one end of the field to the other, upon any force attempting to cross it in the open. Now, this is the advance made by one gun, of which no particular notice has been taken. How would it have been with Bonaparte's close and heavy columns, in coming up against another arm—which Captain Schaw has not mentioned—the "Schnieder?" I give the answer of a French military authority, as to the "Chassepot." On the 27th of December, 1867, Captain Regius, one of the veterans

of the first Empire, said, in a discussion in the Legislative Assembly, on Army Organisation, "When the range of the musket was 250 metres, and it discharged "one ball a minute, the time it took a column of attack in traversing that distance, "was four or five minutes. Although we lost men in doing it, we did it. But now "with the new arms of precision, the range is 1,000 metres, and the rate of discharge "is seven or eight a minute. A column of attack will be exposed for fifteen or "twenty minutes to the fire of the enemy in getting over that distance. The "column must be annihilated before it could get at the enemy." The common practice in France with the Chassepot by the rank and file is, as it has been stated to me, that at 1,000 metres, one out of five shots, hits; at 400 metres nearly two out of five; at 200 metres more than three out of five, hit. So that the nearer his heavy columns approached, the more sure would have been their destruction from small arms alone; and their approach would be not as against the "thin red line" upstanding, but against men of the colour of the earth, or earthy, down lying, with no more than the head or a ninth of the surface exposed; and putting the infantry soldier who advanced upstanding, or "offence," to a disadvantage of nine to one. How it would have been with charges of cavalry, a French experiment will answer. In a simulated charge of *Cent Guides*, against 80 foot of the Guard, armed with the Chassepot, the distance of the charge was 400 metres. The *Cent Guides* got over that distance in 32 seconds, during which time the foot soldiers fired 326 balls, of which 150 hit the target, or one and a half hits for each horse soldier, so that the cavalry would have been annihilated in 32 seconds, without having reached the enemy. A friend who is conversant with the subject, and who has recently spent some six or seven weeks at Chalons, with the scientific and other French officers there, reports as their general conclusion, and of the Army there, that there is an end of charges of infantry and of cavalry,—that there is an end of all systematic combats with *l'arme blanche*. It is said by cavalry men, that there will yet be use for them, for pursuing the enemy when disordered by artillery fire. But men are taking revolvers with them for their individual protection against surprises, and surely he who flourishes a lance or a sword, flourishes a folly against an Adams' revolver, which discharges shots almost in seconds, and puts an average of shot in a space less than a man's skull, at 60 yards distance. Skirmishing advances with great skill; dodges and sudden surprises are the only work now conceived in the French Army. The pomp and circumstance of war is gone. Ensigns are death to those who carry them, and advances must be made crouching or crawling. In short the conclusion at Chalons is, that the future of war will be "a war of serpents." But it is just the war that will give the greatest advantage to alert defenders, like our Volunteers, who know and possess every part of the country, and can make the most of every wall, or building, or hedge. Particular instances may be adduced to establish fully my general conclusion, although the trial of the new arms, large and small, has been very incomplete; they have been applied only partially. In some instances the small arms, and those not the best, have only been used sparsely, and in others, and those few, the new artillery, without support from the new small arms. I am unaware of one instance of an entire battle array, and of a complete instance of the application of all the new arms; and an exemplification of what they will do; and we here by no means get to the end of what science will do, with all arms, large and small. My friend Sir Joseph Whitworth will not die happy until he has provided the means of destroying life and property at seven miles distance, for then he considers he will have provided the means of ensuring peace between civilised nations; and that men will not be got to go out and fight those they can no longer see. The range of heavy ordnance is spoken of as being now between four and five miles. But with his 9-inch gun it is between six and seven miles. He has obtained with it a range of six miles and one-third. Indeed, he has not tried the extreme ranges, and may now have obtained his desideratum of seven. He is a man, from my observation of him—and I have known him a long time—who always does more than he says he will do. He says he will now throw a 1,500 lb. shell six miles and a third, and which will go through twelve inches of armour-plate. In the accounts of recent Prussian field exercises, it is said that the enemy were "seen massing in the distance," but if an enemy were seen massing within the range of such a gun as this, or even within the range of his smallest

3-pr., which puts an average of shot and shell within a square of five hundred yards, at five miles distance, they would be massing for destruction. The artillery practice, as recently made near Portsmouth, was reported as demonstrative of a large gain to the defence from the new arms. Under such conditions I must submit it as established conclusively, that whilst the new arms of precision give one to offence, they give at least three to defence. An American General of experience in the late war, on a visit to England, treated the notion of an invasion of it, with its ditches and hedges, with its walls, with its means of covering infantry, and other means of protection, as a benighted absurdity, and he did so on the last experience of the recent war in America, when it was found that neither side make way against each other in such cultivated country, even with their less perfect arms than those now proposed; and that later experience led very much to the conclusion that he who attacks in such country is defeated. On such grounds I must submit that the military testimony, as far as I have heard it, goes further, and with more certainty and positively as to the gain of defence over offence, particularly in France, than the writer of this paper has stated. In only one instance have I heard of an apparent gain to the attack over the coast defence, and that is the very case of Sir Joseph Whitworth's, with his large shell gun. If he is enabled to throw a shell of the enormous magnitude of 15 cwt. six miles and a third, a boat with that gun would at that distance be a mere speck—and the shifting speck would easily hit the large fortification, Portsmouth or Cherbourg, whilst, I suppose, artillerists would find it a difficult task from that distance to hit the shifting speck. I imagine the coast defence must be, not in the now helpless great fortification, but in quick-going scout-boats, in large gunboats, to go out and have their heavy gun duels in the distance, to keep off the mischief. Some foolish people exclaim against the expense of experiments, and the trial of new arms. I consider that those trials ought to be encouraged, and carried to the uttermost, as means of immense eventual economies of war force, and expenditure. I took part in a congress of statists and economists, civilians, and civil servants of the chief states of Europe, as also of the United States, held at the Hague, last autumn, when I brought the question under consideration, as a great question of international as well as of national economy. I was enabled to state upon French authority, that little Belgium was now enabled, if she were so minded, to withstand great France, and so might little Holland, of itself alone. There is a very able treatise by an Officer of the *Corps de Genie* of the French service, which I have shown to various military friends here of the scientific corps, proving that France, with 100,000 men, could stop an invasion by the force that such a power as Prussia could bring into the field. This being so, the people of France, the taxpayers of France, may ask why they continue subjected to the burthen of 400,000 or 500,000 of an offensive force, and that a force which, not Prussia only, but even Belgium or Holland could withstand: and the peoples of surrounding nations may make the like remonstrances.

The CHAIRMAN: Perhaps you would now like, Captain Schaw, to make some observations upon what Mr. Chadwick has said.

Captain SCHAW: I can only thank Mr. Chadwick for his testimony in support of what I have brought forward. I have the idea that the defence has gained over the attack. He seems to hold the same view, in fact more strongly than I do. I think, however, as, indeed, he has observed, that the very long range of modern artillery (six miles and a quarter, which Mr. Whitworth claims), is rather an advantage to the attack than to the defence in some cases. If we had had rifled guns at the battle of Waterloo, it would not have prevented the French from attacking us, for the French would probably have been furnished with the same class of guns, and would have used them with equally destructive effects against ourselves. As regards infantry tactics, some interesting publications have lately appeared, entitled *Conférences Militaires Belges*, one of which refers to this subject. It is proposed that in future attacks the infantry should advance, masked by skirmishers in front, who should take advantage of any cover that may present itself; and that under cover of the smoke produced by these skirmishers, the main body should work up, until they are near enough to make the final advance. Those seem to have been the tactics of the Prussians in their last war; but as Mr. Chadwick has observed, there has been

no example where modern improvements in fire-arms, on both sides, have been tested on equal terms. The Prussians had an immense advantage in the last war, therefore that can hardly be taken as a fair criterion. In the case of a cultivated country like our own, I cannot say that I feel perfect security, on account of the cover given by fences, hedgerows, &c. It appears to me that war is now, more than ever, a question of manœuvring, a "war of serpents;" and those who are the wisest serpents, and can manœuvre the best, will have the best of it. And more particularly is this the case in a close country, where you cannot get the advantage of long ranges, and the movements of your adversary are concealed. You must be prepared to take advantage of openings, and those who can take advantage of them most quickly, will win.

The CHAIRMAN: In asking you to allow me to thank Captain Schaw for his very able paper, I must tell you that the Council feel very much indebted to him, because as Professor of Fortification and Artillery at Sandhurst, Captain Schaw has a great demand upon his time; in coming here, therefore, he has come at great inconvenience to himself.

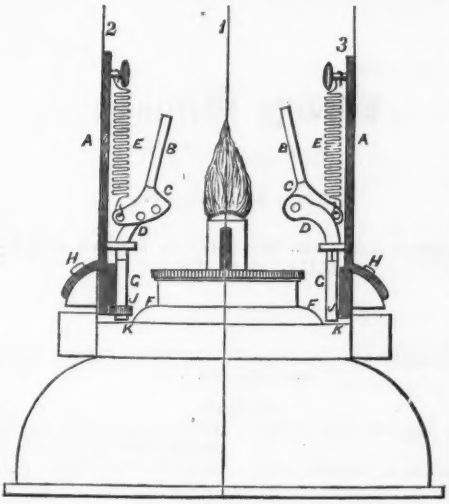
COMMANDER GILMORE, R.N., exhibited a safety-lamp of his designing for use in mines and ships. He said, the lamp is so constructed that on the slightest attempt to tamper with it or open it, it is immediately extinguished. It is thus taken out of the power of a careless miner or sailor to get at the light either for the purpose of lighting his pipe or to get more light for his work. The present so-called safety-lamp is easily opened, and the exposed light is the frequent cause of explosions of fire-damp in mines and of fire on board of ship. I was stationed for some time in Wales and I constantly heard of explosions, accompanied generally with awful loss of life and destruction of property; on two occasions the number of people killed exceeded sixty. On nearly all occasions the old story was repeated: there was found the dead man, his *open* lamp by his side, and scattered around him his dead comrades slain by his carelessness.

Hearing constantly of these horrors, I began to think that a stop might be put to them by inventing a safety-lamp that should be one in reality, one that should set the miner at defiance; and after much work and many experiments, I made the lamp which I now have the pleasure of exhibiting to you. The safety apparatus can be fitted to any lamp; and I intend it as much for the protection of my brother-sailors on shipboard as for my grimey countrymen under ground.

The burning of the "Kent," East Indiaman, with a number of troops on board, will be in some of your recollections. Her destruction was caused by the second Officer using a naked light in the spirit-room. Not very long ago the "Bombay" line-of-battle ship was destroyed by fire off Rio. I attended the court-martial on the Officers and men of that ship: and from what I heard, there is not the least doubt in my mind that she was set on fire by a stoker who made use of a naked light to aid him while he was stealing rum. I could multiply cases *ad infinitum* of fires on board ships caused solely by the careless use of naked lamps or candles. If lamps of this sort had been in use, many hundreds of thousands of lives would have been spared.

DESCRIPTION OF SAFETY LAMP.

1. Line dividing lamp in halves to show both sides of apparatus.
2. View of Safety Apparatus, from left.
3. Ditto ditto, from right.



A, iron plate secured inside lamp by clamp H, which is screwed on to rim of lamp. B, extinguisher. C, tumbler. D, connecting-rod. E, spiral spring, secured to bolt at one end, and to tumbler at the other. F, catch, being part of the thick end of A. G, let-go. J, shoulder on G, which rests on catch or projection F when the lamp is set. K, oil holder.

To set the lamp, push up the extinguisher, and put the shoulder J of G on to the projection (F). When the lamp is being screwed up, the let-go (G) is pressed against F; but on unscrewing, the top of the oil-holder (K) takes the lower end of G, throws it off the catch; the spring E comes into play, and brings the extinguisher down on the wick, instantly extinguishing the flame.

The CHAIRMAN: Your invention is solely the self-acting extinguisher; with that exception it is the ordinary Davy lamp?

Captain GILMORE: It is an improvement upon the Davy lamp, as in my lamp, it is out of the power of any man to open it without extinguishing the flame.

The CHAIRMAN: It requires no lock?

Captain GILMORE: No, it locks itself in the act of closing, and puts itself on a hair trigger.

A MEMBER: I wish to ask to what part of the ship you would appropriate this lamp?

Captain GILMORE: To the magazines, the spirit-room, or any other part you like. You can take the lamp in and turn it round in the middle of gunpowder without danger.

A MEMBER: Does it produce as much light as an ordinary lamp?

Captain GILMORE: As any glass lamp; it is merely a question of degree. For ship's use I should have a glass globe lamp; you would not require the same amount of security on board ship that you would in a mine, the wires forming the mine safety-lamp are so close together, that the fire cannot get through. There is not space for sufficient oxygen between the meshes to support the life of the flame. The lamp is trimmed from the outside by a pricker, and as the lamp will burn for eight hours, there is no need to open it during a man's spell underground.

The CHAIRMAN: We will now bring the meeting to a termination, by thanking Captain Gilmore for exhibiting his safety-lamp.

Evening Meeting.

Monday, April 4th, 1870.

LIEUT.-GENERAL THE HON. SIR JAMES YORKE SCARLETT, G.C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between 21st March and 4th April, 1870.

ANNUAL.

Clutton, Owen, Major 7th Surrey Rifle Volrs. 1*l.*
Halpin, The Rev. R. C., Chaplain to the Forces. 1*l.*
Hill, Rowland, Lieut. 39th Regt. 1*l.*
Ormsby, Wm., Capt. 1st W.I. Regt. 1*l.*
Clark, Percival, Capt., retd. 9th Lancers. 1*l.*

THE PROGRESS THAT HAS BEEN MADE IN THE APPLICATION OF THE MONCRIEFF-SYSTEM TO GARRISON, SIEGE, AND NAVAL ORDNANCE, AND TO COAST WORKS.

By Captain A. MONCRIEFF, Edinburgh Artillery Militia.

The CHAIRMAN: I have the pleasure to announce that five annual members have joined the Institution since our last meeting. I only wish there had been more, as we wish to have as many members as possible. I do not think the Institution is sufficiently known in the Army, or sufficiently patronized. I can only say that I shall be happy to double my subscription if it is wanted; but we do wish to get as many members as possible to join the Institution.

But to proceed to the business of the evening, Captain Moncrieff, of the Edinburgh Militia Artillery, will now explain to us the progress that has been made in the application of the Moncrieff-System to garrison, siege, and naval ordnance, and coast works. I believe most of you have some knowledge of the gun-carriage which he has invented, and the processes by which it is worked. He will give us further information to-night, and probably describe some improvements he has made in the system.

Captain MONCRIEFF: Since I first read a paper in this theatre, the subject of it has had an eventful history. The system which now

bears my name is gradually, but surely, becoming acknowledged and acted on, both at home and abroad.

This system consists of three parts—

1st. Of various contrivances for dispensing with a raised parapet for artillery, by means of counterweights, &c.

2nd. Of arrangements for placing the artillery so mounted in favourable positions.

3rd. Of arrangements for laying, sighting, range finding, internal communication, &c., adapted to the altered conditions and requirements of a position thus armed.

The system may be said to have two aspects, an artillery, and an engineering one, both of equal importance; and in applying it properly, both must be kept in view, in order to get the full advantage it is capable of yielding.

The gun carriages have to be made with those appliances which will best suit them for the positions in which they will be placed, and on the other hand the works themselves should be designed in such a manner as to get the greatest results from the artillery mounted on the new plan.

It is difficult fully to appreciate the radical change of conditions imported by the new system, without actually attempting its application. Up to the present time the trace of works and the systems on which they were formed, were based to a great extent on conditions that are now removed. These conditions, simple as they were, guided nevertheless the pencils of all military engineers, from Vauban downwards, and gave form to those many lined and cunning designs for flank defence characteristic of modern fortification. An exterior slope, a pierced parapet, guns cramped in their action and lateral range, such were the conditions which are now swept away by the new system.

The problem of fortification is thus far simplified. This advantage, however, would probably not have been sufficient to force on a cordial recognition of the new system at present, had it not been for the wonderful advance that has taken place in our own time, in the science of artillery.

The penetration and precision of direct rifle-fire from modern ordnance called for stronger parapets, and smaller embrasures. The old earthen or masonry parapet, which was sufficient to resist ordinary spherical shot, could not withstand the elongated rifle projectiles; and that parapet had not only ceased to be a protection, but actually became a danger, as it just offered sufficient resistance to burst large shells, or was thrown in upon the detachments by solid projectiles.

These potent reasons compelled the use of iron shields, casemates, and turrets.

The great progress, however, in the science of artillery since 1855, has been restricted mostly to the guns themselves. The carriages for these guns were certainly improved, or they would not have been sufficient for their work; but that improvement was confined to increased strength, and to various methods of stopping the recoil by friction, by the use of compressors, &c.

The violent nature of the force of recoil in the new artillery was,

and is, a constant source of difficulty and expense, but I trust it has now been successfully grappled with, not by improving this old system, but by changing it completely, and by utilising the recoil; thus on the one hand getting rid of the principal difficulty, and on the other avoiding the necessity for using iron, which, as before stated, had become the only alternative.

It is not necessary to dwell on this subject, as you are already acquainted with my method of procedure. I shall now offer a short description of a few of the designs of Moncrieff carriages that have been proposed, and which are now being carried out for the British Government.

A great proportion of the whole work in the Royal Carriage Factory during 1869 consisted in manufacturing the 7″ muzzle-loader 7-ton Moncrieff carriages now in the service. This carriage is very much the same as the first one experimented on at Shoeburyness. It differed only in some improvements in the gearing and other alterations made by me after the decision to adopt it was taken. Next in order I shall take the 9″ 12-ton muzzle-loader Moncrieff carriage.

It will be noticed that in this case there is a great change in the arrangements adopted. Some objections were made to the 7″ 7-ton carriage, because with it there was only 3′ 6″ between the height of the gun in the loading and firing positions. The cover thus afforded was considered to be barely enough. I have accordingly met this objection in the 9″ 12-ton carriage, by making the gun descend 6 feet by the recoil, thus giving much greater cover. The men while loading are protected overhead by the counterweight, although that protection may be said to be almost unnecessary; but a stray splinter might by chance descend vertically, if so, the counterweight would form a strong roof to intercept the falling body. The top of the counterweight is under the crest, and is shaped so as to throw off any shot or splinters that might impinge on it.

In this carriage, the gearing is changed completely, and it will be observed that it is all brought down much nearer to the ground than in the 7″ 7-ton carriage, and to a convenient position for the detachment.

Various other improvements have been designed for this important class of artillery in the way of making it more simple and less expensive, but I trust I may be excused for not entering into all such details, as in my present position it would be unadvisable.

Besides the designs for 7-ton and 12-ton M.-L. guns, a number of other designs for smaller artillery are being matured; and at the same time my labours are being applied to the means of mounting still heavier artillery than any to which the system has been yet applied. I may also mention that designs for 7 lb. breech-loaders and 98 cwt. guns were last year submitted to the Director-General of Ordnance, for Moncrieff carriages, in which the recoil is received on springs. These carriages have parallel action and fixed fulcra, and are the same as one of the designs submitted to General Sir R. J. Dacres, K.C.B., in 1858, and reported on by him to the then Secretary of State for War. They have lightness and compactness to recommend them. On some future

occasion I may have the pleasure of exhibiting some of these at this Institution. A Committee has been lately appointed to experiment on, and, if approved of, to pass my new designs into the Service.

I shall now shortly refer to the application of the system to existing works.

Before doing so, however, I shall take the opportunity of mentioning a fact which is not disputed, but which is not considered in estimating the comparative values of the old and the new systems. This fact has so important a bearing on the question, especially in relation to coast-batteries, that I trust I may be excused for insisting on it here. It is one of those facts that entirely escaped the observation of artillerists, except perhaps men of great practical experience, who did not take an opportunity of recording results, but only acted on them.

General Sir Linton Simmons had the merit of not only discovering this fact, but of enunciating and proving the law on which it rests, from the statistics of a lengthened series of experiments at Shoebury-ness. He brought this forward at a discussion at the War Office on one of the professional papers of the corps of Royal Engineers, contributed by me.

The law is, that the mean error to the right or left of a vertical line in artillery practice, is nearly as the distance; but that the mean error above or below a horizontal line, goes on in an increasing progression with the distance.

It is only necessary to state this, to make it at once apparent, that as long as this law holds good, the exposure or liability to be struck in the two cases must not be estimated alike.

The two cases are these:—

1st. That of the old system, which has an exterior slope, a wall, a shield, or casemate, with their ports; all of them standing a given height above the line of glacis, and visible to the enemy.

2nd. The other case, viz., the new system, in which the vulnerable area exposed to direct fire is only a horizontal line, presenting nothing visible to the enemy.

The gun is exposed in both cases, in the latter, only while firing; in the former, it is somewhat covered when the ports are very small, but is permanently exposed.

To illustrate this practically, let any good rifle shot be asked what would be the comparative chances of hitting a target facing him vertically, or of planting a bullet on it while it lay flat on the ground.

The danger of the exposure of this narrow horizontal line has not had any deduction made from it on account of the difficulty of hitting it by artillery fire.

It is very true that there is a heavy enough balance in favour of the new system, without adding this consideration; but I submit that it is a good deal more important than would appear at first sight, and in taking a general survey of any position with a view of planting batteries, it would be a mistake to ignore the consideration. This, in conjunction with the invariable experience of naval attacks on land works during the American war, formed part of my reasons for recommending the 4th provision to be attended to in laying down

Moncrieff batteries for coast defences referred to in another part of this paper.

The adaptation of the new system to existing works gives rise to questions of great difficulty and embarrassment, which do not exist when new ground has to be broken, and where the system can be applied in a complete manner.

When the existing coast batteries were laid down, the conditions of naval attack and defence were very different from what they now are. Some of our coast batteries are very powerful works. It may be said of others that they are not well suited for the new conditions. But as a great deal of money has been expended on them, and many still fondly cling to the traditional methods handed down to us, the question becomes a compromise between the two systems; and the object is to get as much advantage as possible by their combination.

When the Government made arrangements with me in regard to the adoption of my system, it was provided that in all cases where that system was applied, the designs for the works were to be submitted to me, in order that I might have an opportunity of making my remarks in writing thereon, for the information of the Defence Committee, before their final decision was given. This duty I feel to be at once a great responsibility and a privilege. It was certainly right, that while the old system had so many supporters who were well acquainted with it, and who could ably place its advantages before the judges of the impending change, the new system should at least have one advocate well acquainted with its provisions; and its author was likely to be best acquainted with his own system, and was on that account a suitable person for this duty.

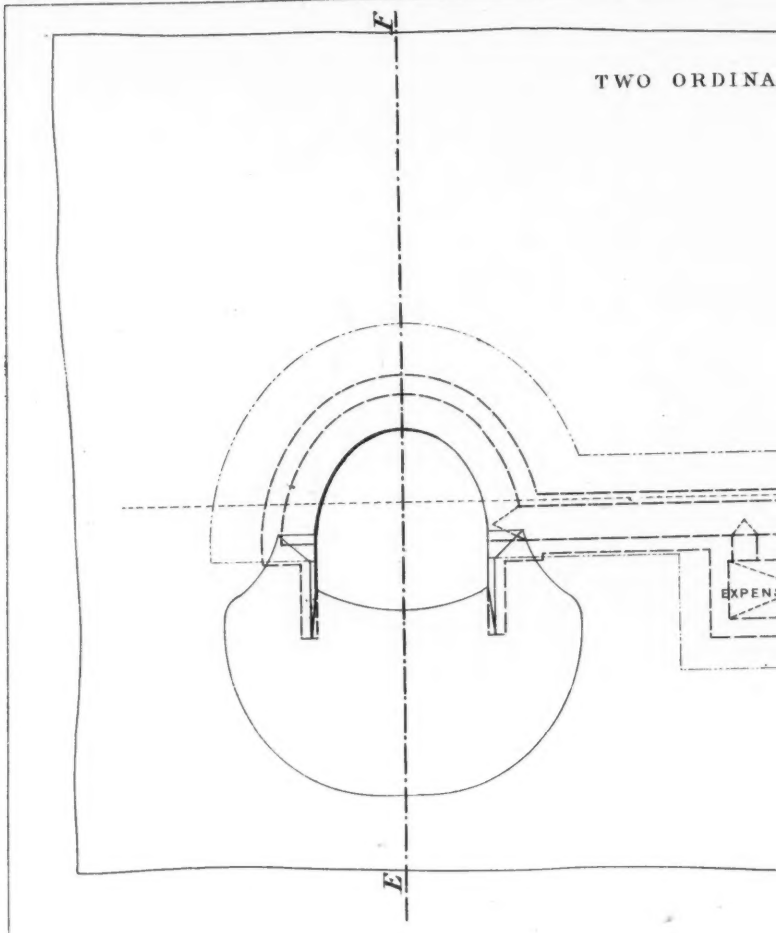
I sincerely trust that I may be able to give complete satisfaction to the Defence Committee in this capacity, and be considerate and explicit when called on to state the aspect of each case from my point of view.

I have myself only studied the question thoroughly in relation to coast defences, in order to form out of it a consistent whole, in which the carriages, the formation of batteries, and the position of the guns in relation to one another, as well as the tactics that belong to the new dispositions, might all receive consideration in relation to each other; and it will be found that my carriages consequently possess all the appliances for working this system in its mature state.

If time admits I shall endeavour to explain some of these arrangements, although it will be impossible to do so in much detail, as I have a new subject to explain at the end of this paper.

The conditions of coast defence vary very much in different cases, and therefore no general law can be laid down. It sometimes is required to stop the passage of a navigable river or channel, in conjunction with marine obstacles, and mines or torpedoes; in other places to guard the approaches to a harbour, dockyard, or arsenal; or it may be merely required to prevent a hostile landing.

Batteries sometimes are embraced within an armed position, and do not require provision for flank defence; or they may be exposed to a rush, and provision against this, would be an element in their disposition.



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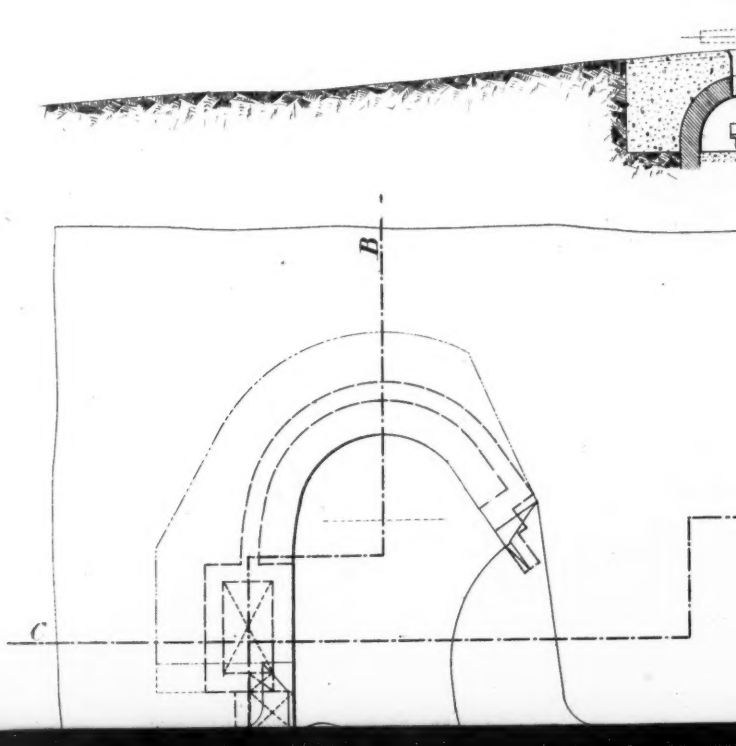
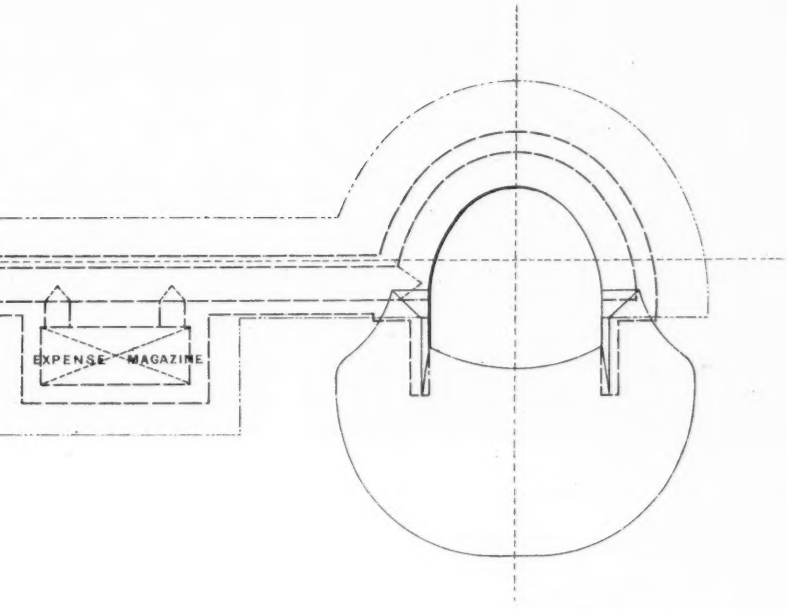


ORDINARY TYPES OF GUN EMPLACEMENTS
IN A MONCRIEFF WORK.



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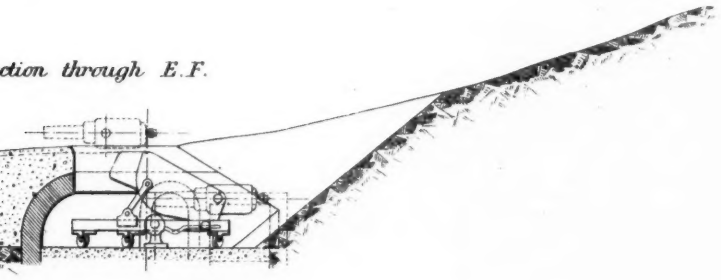

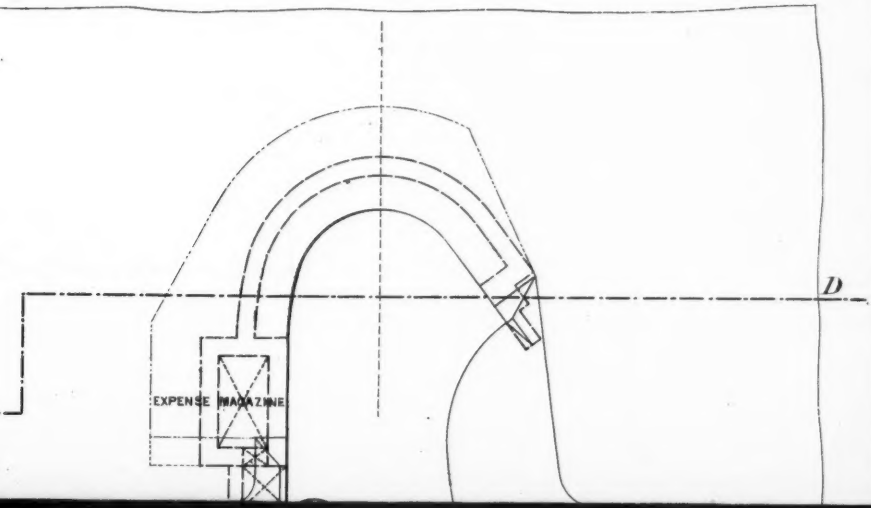

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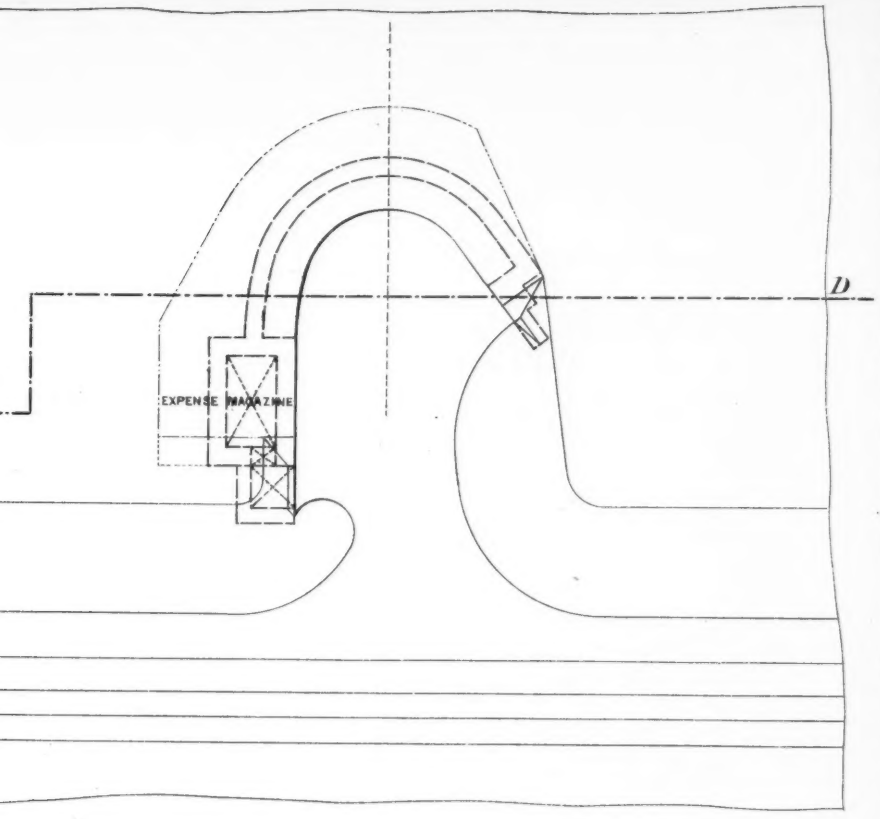

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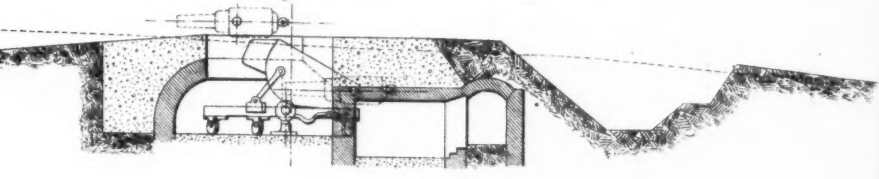

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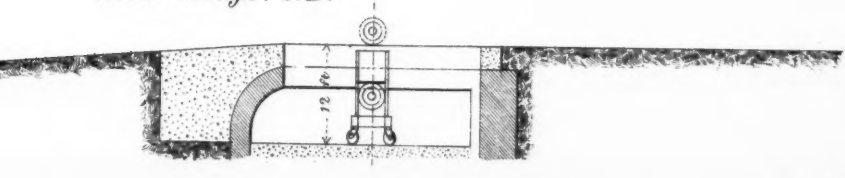

Scale, 20 Feet to 1 Inch .

J Jobbins

The ground will sometimes afford the advantage of low and inaccessible mud or sand banks, where the guns could be mounted to greatest advantage, à fleur d'eau; high command in other cases, would place the artillery at considerable advantage.

In any case, however, in which Moncrieff batteries are used for coast defence, I think the system is best carried out when the following conditions are attended to:—

1st. That the guns should be scattered, so as not to draw converging fire from ships, but to be able to converge their fire on them; and so that they shall not be encumbered in action by their own smoke.

2nd. That all natural advantages should be seized as a means of disguising or masking the exact position of the guns.

3rd. That the guns should be so arranged as that each shall have as great an opportunity as possible of using the new powers of traversing conferred by the system, either in attacking the ships, or in covering the ground in front of other guns.

4th. That batteries should be generally well retired from the channel, so as not to be readily approached from ships, and so that the increased precision of land-fire over ships'-fire would tell to their advantage.

5th. That provision for protection to the men should be made by giving them a space well defiladed for working in, and bomb-proof cover, if it can be afforded.

6th. By attending to the materials used in forming the superior slope, the angle of which should always be sufficiently low as to cause ricochet with such material as may be used.

On account of evidence given by me before the Committee on Fortifications, the Secretary of State for War called upon me, through the Director of Works, on the 15th June, 1869, to give in designs on my system for several positions, consisting both of adaptations and of entirely new works. The most important of these is Cliff End, Isle of Wight; it is calculated to cost a very small sum, as designed by me, and has an armament of twenty heavy guns. On account of the ground selected, I venture to say that there is no coast work in England, whatever it may have cost, that an impartial judge will pronounce more formidable, in its particular position, than this work. If now carried out, it will be the first pure Moncrieff work of any importance made in this country.

There is another aspect of this important question which should not be overlooked, viz., the capabilities of the new system as applied to extemporized works. Whenever the strategical questions connected with the defence of the whole country are considered, the enormous importance will be recognized of being able to form earthen batteries at comparatively short notice, equal to cope with ironclad vessels with heavy guns; in other words, to retain the power of being able to develope the defence where attack is expected. The time may arrive when the suggestions made in previous papers of mine on this subject will be carried out; when positions of importance will be acquired by Government and the ground prepared to a certain extent, but not so far as to require maintenance, or to be quite ready for its

armament. It is a satisfactory consideration that the net work of railways in Great Britain, if only slightly extended on strategical principles, is capable of supplementing its existing defences to an enormous extent at a comparatively small expenditure.

The formation of coast roads; of a few depôts of heavy artillery *matériel* at the conjunction of railway lines; and an organization capable of applying all the advantages of internal lines of communication such as probably do not exist to the same extent in any other country, should go some way to meet the increased power of attack that steam navies confer on an invader.

Regarding the 6th or last provision recommended in erecting Moncrieff batteries, I am unable to give you much information. It would be possible to say a good deal about the best kind of armour for shields, as many experiments have been made to determine this; but although the other question applies to both the old and new systems, no proper experiments have yet been made for it, and consequently the theories on the powers of different substances to deflect rifled projectiles at small angles are all founded on the loosest data.

It is generally quite forgotten by the lovers of iron that the sill of a shield or embrasure, or the base of an iron casemate, is probably more liable to be injured by a shot than the crest of a Moncrieff emplacement.

I have not been able to do as much as I could wish lately in developing a most interesting part of the new system, viz., the 3rd part, from the great press of work that has fallen on me in connection with the others.

This 3rd part consists in the arrangements for range-finding, internal communication between the batteries, provisions for working in concert during action; in fact, the tactics of the new system, and the appliances for carrying them out.

With the magnificent and costly artillery that must now be used against ships, it would be a mistake of the most inexcusable kind to neglect the means of making the fire of the guns as effective as possible.

A 600-lb. shot which misses is as harmless, although much more expensive, than an old 32-pounder; and to find the range by trial shots is both a rude and unsatisfactory means of attaining the object in view. My method is the following:—

A long base line within the position is selected, and the whole channel is laid down on a chart, with radial lines from points at the extremities of this base.

The exact position of any point on the chart can thus be described by two angles, these being the angles between the base line, and lines from its extremities to the point referred to, read at such points of observation.

Each gun is provided with a copy of this chart, which at the same time has its own position or pivot laid down; radial lines from that point correspond with a graduated racer, and enable the gun to be traversed while in the loading position, and to fire on any required part of the channel.

At the same time concentric lines, indicating the range of the gun, enable the detachment to determine the required elevation and give it by means of the trunnion-pointer, or platform tangent-scale.

The possibility of laying correctly by these appliances has been proved by experiment.

Means are provided for giving, by electric wire at each gun, the angles from the two points of observation. The chart at once indicates by inspection (from the two angles formerly referred to) the position of the vessel, the point to which the gun should be trained, and the elevation that has to be given by means of trunnion-pointers.

The gun can thereby be laid correctly without calculation or delay, and, if the object is moving, it is laid in front and fired at the proper moment by watching the transit of the vessel across the field of the Moncrieff reflecting sight.

Electric instruments have been designed by me for indicating the position of a ship at each gun mechanically. When the vessel is obscured by darkness or smoke the guns can be correctly directed on it and fired by electric fuses, or by electric signal from the point of observation, where its position can be determined by powerful night glasses or otherwise. These few remarks convey but very inadequately the simplicity and completeness of the proposed method. All my carriages are provided with the means of carrying it out. It would require a separate lecture to describe the details of the method properly, and I trust you will excuse this short and imperfect description.

Besides the general means for determining ranges above referred to, each battery should have independent means of doing so. This would be the more necessary for guns having considerable command, as a smaller error in that case, would carry the shot over, or under the vessel. I have designed an instrument that will give the distance with considerable accuracy in batteries of high command by the measurement of the vertical angle.

The drill of the artillery would be regulated, and its efficiency judged, by the alacrity with which it could direct its fire on rapidly-moving, or imaginary objects, the practice being carried out in concert under the immediate orders of the officer conducting the supposed defence. In connection with this part of the subject, are the arrangements for connecting the batteries by proper and covered roads, together with lines for infantry, and for the passage of reliefs; also the occasional disposition of howitzers or other light artillery for internal defence, placed as an additional provision against successful assault.

In all cases where the system is intended to be properly applied for coast defence, I should recommend the employment of the most powerful guns available; and the first consideration in placing these guns should be how to get the most out of them in offensive power, and next to consider how they are to be protected from assault. I am convinced that, in the majority of instances, this would not only be the most efficient, but also the more economical method.

I make these observations in this place to show how necessary the 3rd part of the system becomes if the dispositions are carried out on the principles laid down.

The guns would then no longer be compressed into the smallest possible space, in which they offer a temptation for mortar fire, and are sometimes blinded by each others smoke, but they would be spread out and detached; in which case all the arrangements I have mentioned, and others of the same kind, would come into play, and would indeed be necessary.

I shall now pass to the application of the system to naval ordnance.

The value of floating batteries arises from their mobility; and many advocate the employment to a great extent of this method of defence. It has much to be said in its favour, and it will always form a valuable adjunct to land works.

My efforts have been directed to this subject for a long time, and I believe that the counterweight system now adopted by the Government for land works, could be used in floating batteries in smooth water, and in that case would yield in a limited degree some of the advantages gained on land, by enabling low gun barges or iron monitors to work their guns below the water level, and to deliver their fire with the protection of a much smaller iron gunwale than is now required.

I have been baffled, however, in every attempt to apply the system to seagoing vessels, on account of the difficulties imparted by the rolling of the vessel, &c.

I need not dwell on what has been done in applying the system to floating batteries for smooth water, as a long series of investigations in connection with another principle, has led to the development of a new invention for naval service, which will be equally applicable to seagoing vessels and to floating batteries.

This new contrivance is as different from the system now adopted for land service as could be imagined; there is in it neither a moving fulcrum nor a counterweight, which are the grand characteristics of the land service carriages.

Instead of using the force of gravity, pneumatic agency is employed as the balancing force.

Before describing this new invention, and leaving what has already been done, I would ask you to glance again at the system now adopted for land works.

When I went to Woolwich nearly four years ago, by desire of the Secretary of State for War, there was absolutely no satisfactory method of meeting the fire of modern artillery, except by parapets of wrought-iron. Committees appointed to investigate the subject had given forth their decisions that this material alone could be relied on, and both military, and public opinion, had concurred in these decisions.

Preparations for carrying them out were made; and many of the coast works of England, that will now be completed on my system, would by this time (had not that alternative been at hand) have been fitted with as costly bulwarks as are required on our ships of war.

It was contemplated, and indeed it would have been most advisable, to use iron turrets largely in our works; as many as 27 of these for two guns each were estimated for at one time. Later experience has shown that it would probably have been expedient to use only one gun

in each turret. Iron casemates and shields would have been necessary for almost every gun.

It is now probable that no turrets will be required, and an idea of the saving on this item alone may be formed when I mention that a turret with its appliances, without the guns and carriages, costs at the smallest estimate £20,000.

Future works will be erected at a mere fraction of the expense they would have cost without the new system, and the artillery which they mount will at the same time possess much greater offensive power from the increased lateral range.

It will moreover be now possible to form defensive batteries in positions and under circumstances where the expense and other disadvantages would have previously only tempted destruction from ships' fire.

A few light guns can now engage even an iron-clad, whereas previously the expense and difficulty of giving them sufficient protection, would have precluded the idea of using ordinary guns against the powerful ordnance of ships.

A good "Moncrieff emplacement" is as proof against a 600-pounder as against a field piece; and indeed is less likely to receive injury from a few heavy guns than by a corresponding force of smaller pieces; in short, a revolution has taken place in coast attack, and defence.

The Hydro-Pneumatic Carriage.

At a discussion here on the 1st February, 1869, on General Hutchinson's paper,* I stated that I had been working for some years on designs for naval purposes in which the recoil was absorbed by pneumatic agency, and that on some future occasion I should describe at this Institution the method employed. I now redeem my promise, and would enter still more fully into particulars, but for like reasons to those formerly alluded to.

The contrivance which constitutes the new invention is very simple. I have been working up to it for many years, and when I did arrive at the solution, was only surprised that it had escaped me so long.

When a large induction indicates the necessity for a certain device, and at the same time points to generous natural laws lying waste as a means towards that end, the inventor's problem is often solved, as in this case, by some simple expedient that is self-evident when propounded, and which is more or less analogous to a result of natural selection, or to a method of nature herself. Like, I dare say, many others, I have for a long time been trying to derive from pneumatic agency the means for working naval artillery.

The elasticity of air provides the most perfect spring that can be conceived, and in order to utilize the recoil of ordnance it was but required to apply this spring neatly, cheaply and securely. The difficulties of packing, of leakage, of adjustment, &c., stood in the way of this.

* "Recoil Utilized." By Lieut.-General W. N. Hutchinson. See *Journal*, vol. xiii, p. 75, *et seq.*—Ed.

At last, as Watt thought of his separate condenser, I conceived the idea of a separate vessel for my air spring, and of working and adjusting the carriage by hydraulics. As soon as this idea came into my mind, along with the other appliances that belong to it, I felt as certain of success, as of the advantages to be got by it, and accordingly set to work in earnest to arrange the details for its application. The different plans I have worked on for applying this invention, possess many interesting features, and meet in a remarkable manner existing requirements. It is at once economical and efficient, and I have been much gratified by receiving the warm congratulations and encomiums of eminent engineers and scientific men on my contrivance. The actual experiments have more than confirmed the anticipations previously formed. It is suited for vessels of different character, and has many applications.

In a great maritime country like England, anything which is capable of increasing the efficiency of the Navy, must be looked on by all intelligent men as of great importance. We now lean perhaps more than ever on our gallant sailors; and the Navy is indeed more than ever it was before, both our weapon and our shield.

If, therefore, I am able to give our Navy an invention that will go some way to lessen the two greatest difficulties which now attend the armament of its ships, I shall feel conscious of having performed a good service for my country.

The two difficulties which at this moment most hamper the Navy are these—the one is connected with the defence of the ships, the other with their power of attack.

The former is a grave one, as it is nothing more nor less than the difficulty and expense of giving sufficient powers of floatation for the armour that is now required, with the engines, fuel, guns and ammunition of a war ship.

The second difficulty is that of working the ponderous artillery that is now used on board ship; this difficulty I need not dwell on, but it is well understood by the initiated; in some cases even British sailors shrink (at ordinary practice) from the painful duties at the guns.

I hope, gentlemen, to offer to reduce the former difficulty very largely, and to entirely remove the latter.

For reasons which will be understood by inventors, I have not till now been able to divulge the simple process which is employed.

I submitted my plans on the 28th October, 1869, to Mr. Childers and the Admiralty, but this is the first occasion on which I have been able to invite the Naval profession to examine and to criticize these plans, and I await with confidence the judgment that may be pronounced on them to-night in this theatre.

To describe the new process in as few words as possible: it consists in applying the combined action of hydraulics and pneumatics in a variety of ways to heavy ordnance, some of which are illustrated by the diagrams and models.

Let us take one of these, for a 12-ton 9″ gun, as an example. It works on a platform 12 feet in length—that is 4 feet less than a naval slide—traverses on a central pivot along with a small circular portion

of the upper deck, through which the gun rises, and throws back the self-acting shutters which close the horizontal port.

When the gun is fired, it descends into the loading position by the recoil, under cover; if necessary, under the water level.

The force of the recoil is not lost but stored; and the simple operation of turning a cock raises the gun at once, and under perfect control, into the firing position.

The adjustment of this carriage for rolling or for different charges is determined with the most perfect precision to the fraction of a lb. per inch by pressure gauges, and effected with ease and rapidity by arrangements I need not here describe.

The carriage itself, which it will be observed is of the simplest construction, is not connected with, but only rests on, the cross head of the plunger, and all the hydraulic appliances are stowed away in safety at the bottom of the vessel, or wherever it is most convenient to place them.

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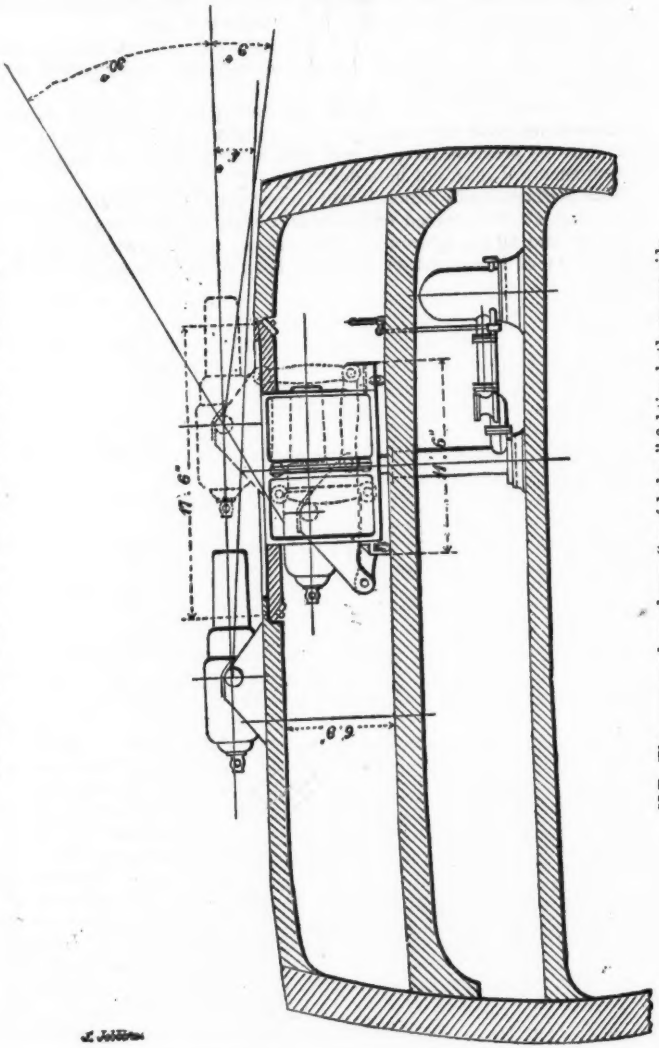
MONCRIEFF REVOLVING HYDRO-PNEUMATIC CARRIAGE.



N.B. The guns are here shown "en échelon," fighting both on one side.

The traversing in this case is done by the engine.

In other cases even the loading is performed mechanically by hydraulics, so that economy of labour is combined with plenty of room for serving the gun, and with the smallest exposure of the men to fire, that has yet been devised.

Whether the method is considered as a possible substitute for the existing broadside or turret systems, I submit that it offers advantages worthy of consideration. In the former case it enables the naval architect to dispense with ports; indeed, with the whole of the armour where the ports are now placed.

An unbroken line of armour without ports is less expensive, and stronger for the same weight.

It removes all those difficulties which encumber the question of training in conjunction with diminished ports, and allows him to adapt any section of the ship's side that gives the greatest resistance without being hampered with questions relating to the thickness of the gunwale, and room for traversing and loading.

It also removes an objection of a serious kind to low ports, viz., that of being submerged on the side to which the vessel heels over. In short, it at once makes unnecessary the expense and the weight of all armour above the deck, and allows the guns to be trained to right or left, without limit or the labour of moving the whole gun on a front pivot.

In the latter case, viz., as a substitute for the turret, it has also something to be said for it.

It possesses many of the advantages of the turret system.

The gun in the firing position is exactly in the same relative position to the deck of the vessel as it would be in a turret, where it is obliged to remain always at that level; it does not, however, as in that case, require a heavy circle of wrought-iron above the deck to protect its carriage and the men serving the gun, as they are all below the deck.

The gun is loaded and worked with greater freedom and ease, with more room and convenience below the deck, and unlike the turret gun, it can be fired at any elevation, however great. The fleet at Lissa would not have been driven off by a few artillerymen at a high battery on shore if there had been even one gun in the fleet mounted with this advantage.

The extra weight of a turret, as estimated by Admiral Halsted, is at least 175 tons, nearly all top hamper. With my system, on the other hand, the weight is only $16\frac{1}{2}$ tons for a 25-ton gun and no top hamper.

The difference in expense is even greater than the difference of weight, great as that may appear. For the fabric of the turret not only costs much money, but the tonnage or displacement of the vessel has to be increased to carry it, and has therefore to be taken into account, and in each vessel this extra carrying power is not purchased very cheaply or conveniently.

Had the system not possessed inherent advantages of its own, independent of economy, the advantage of cheapness alone would have entitled it to consideration.

Sir William Armstrong, in his well-known letter to the *Times* on the 22nd May, 1869, pointed out in an admirable and concise manner the advantages to be gained by vessels of the "Staunch" class, designed by Mr. Rendel. Both Sir William Armstrong and Mr. Rendel are of opinion that the hydro-pneumatic carriage will render these vessels still more effective.

I have been engaged in designing a new class of vessel which becomes practicable with this new method of working naval ordnance. It is simply an adaptation of Mr. Ruthven's most ingenious invention as applied in the "Waterwitch," in combination with the new carriages and other arrangements.*

It will be a creature of singular habits, and addicted to tricks not in keeping with the usages of well-behaved ships. This vessel is designed as a good seagoing craft, with fine lines below water and plenty of freeboard for comfort, and all the qualities that sailors like. She is fitted with hydraulic engines like the "Waterwitch," and built in compartments, but some of these compartments in a proper position in the hull have the following fittings: They have arrangements for opening or closing their communication with the sea. The suckers of the propelling pump can also be made to draw either from the sea or from these tanks. The results of these arrangements are, that when this vessel comes into action she can sink herself almost to the water's edge in a few minutes by opening the before-mentioned compartments to the sea, and with equal rapidity she can empty these tanks by means of her propelling engines whenever that is required.†

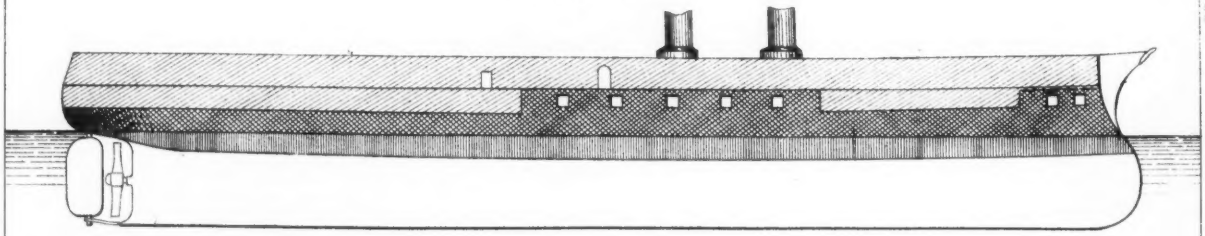
It would be an edifying sight to the intruder into a harbour to see a few such vessels dash into their position for action, and immediately sink almost out of sight, and open fire from concealed guns at the water's edge, while they showed nothing more to be attacked than the appearance of a light grey speck in the distance. It is obvious that the same appliance which can expel so large a body of water in four minutes, would also prevent a vessel sinking by shot.

It may occur to those who have thought on this subject, that if this submerging vessel is quite successful, it will probably lead the way to that combination of seagoing, and fighting qualities, in larger vessels, so difficult of attainment—a vessel that can be armoured stronger than the strongest now afloat (where armour is needed), which can be buoyant and high-sided at sea, low and impregnable in fight, with healthy and abundant accommodation for the crew, who need only give up their quarters in actual battle, to retire within their iron fortress in the middle of the ship. The chance of getting a vessel that would combine all these advantages, and at the same time be

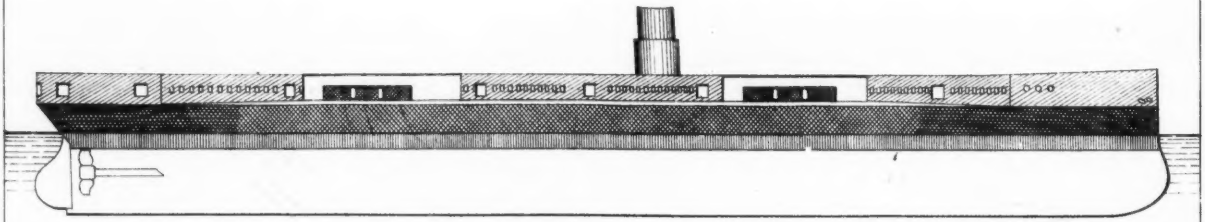
* The gun-boat "Waterwitch," with hydraulic propeller, was tried against sister gun-boats "Viper" and "Vixen," with double screw propellers, all three being of same size and horse-power, and the "Waterwitch" gave better results in speed, &c. See Admiral Eliot's able paper in vol. xi of this *Journal*, page 589.

† With reference to the submerging vessel, Plate xxviii, I may mention that the line of extreme submersion is shown, but that the vessel can be fought at any intermediate time between high and low submersion, according to the state of the sea.

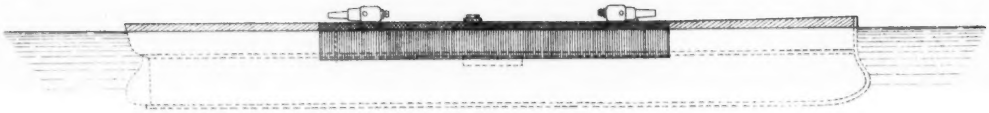
BELLEROPHON



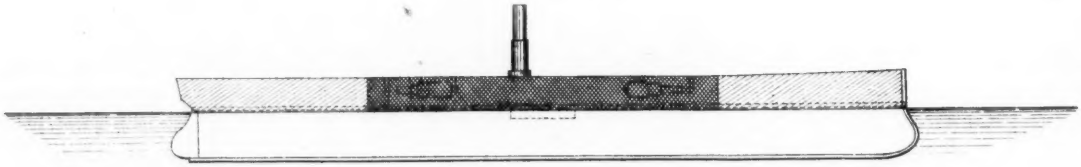
CAPTAIN



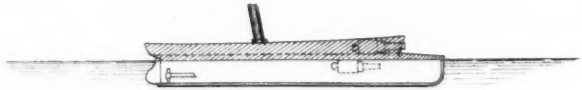
SUBMERGING VESSEL FOR TWO 25 TON GUNS IN FIGHTING TRIM.



Dº IN SAILING TRIM



MONCRIEFF ARRANGEMENT AS APPLIED TO STAUNCH.



MONCRIEFF GUN BARGE

Scale ⅛ Inch = 12 Feet

The parts shaded thus ▪ *are protected by Armour.*
The parts shaded thus ▨ *are unprotected.*
The parts shaded thus ▥ *are submerged Armour.*

J Jobbins

Pl. XXVIII

able to keep herself afloat after her hull was pierced, and all this, too, at a greatly reduced price for the same armament, makes the question at any rate worthy of serious consideration, and would justify a greater experiment than is necessary to determine the question.

It may possibly be held that the small command, or height above the water, of guns mounted in some of these vessels, is an argument against the principle; but in answer to this I must state that if the argument be valid, it only applies to the vessel, but not to the principle; if this high command is considered to be necessary, the elevation of the gun can be obtained more cheaply with the new plan than when the carriage is permanently protected in the firing position by iron. I should wish, however, to point out that the maximum difference in height of guns on board ship is very small.

The height of axis of guns above the water level, for the several classes of ships named, is as follows:—

	ft.	in.		ft.	in.
1. Gun-boat	8	0	5. "Hercules"	13	2
2. "Blanche"	11	5	Upper deck	23	8
3. "Volage"	12	0	6. "Monarch" (turret)	17	8
4. "Inconstant"	11	11	7. "Captain" (do.)	9	8
Upper deck	20	0			

At 500 yards the difference of the angle of incidence of a shot fired from a gun 23 feet above the water, and one fired at 8 feet, is practically nothing.

The small shallow-water gunboats, for which this system is well adapted, would not seek close quarters to engage an enemy, and at long range their fire would be practically the same as if obtained from a platform a few feet higher; the additional height would be but a small advantage to them, and at very close quarters they would be under the fire of a large vessel, and so secure.

The question is, would it be worth obtaining greater command at the expense of the additional weight and exposure which is thereby incurred? Where height is considered necessary however, it can be obtained by the new system, with a lower iron bulwark than by any other that has been proposed. From the exposure of the gun in the firing position being only momentary, there would not be much objection to that position being made higher above the deck than it is now.

I shall not discuss this question any longer; it is quite enough to state that the carriage now before you (even though submerging vessels are not adopted, and that depends on whether Ruthven's admirable invention is successfully applied) will at any rate reduce the weight of iron-clads by all that most expensive part of the armour that is above the upper deck—that is, will reduce the displacement by that amount, and consequently the extra expenditure of fuel and engine power required to propel the vessel, and that it will make the service of the guns safer, easier, and possibly more expeditious.

When it is found to perform as much as this, I trust you will consider that I shall then deserve a generous acknowledgment of my success, and that some of the means now being expended on those

plans which it will supersede, may be soon saved to the country by its adoption.

The CHAIRMAN: I am sure that whatever differences of opinion there may be upon the subject of this lecture, you will all agree with me that we are very much indebted to Captain Moncrieff for the trouble and pains he has taken, and the expense he has incurred, in developing these various inventions, and for the very clear manner in which he has explained them to us. I myself am not at all competent to express any opinion whatever upon the subject of artillery, my branch of the service being of a more general kind; therefore, I do not presume, in the presence of an audience of this kind, to say one word about artillery, but, as far as I can understand Captain Moncrieff's principle, it appears to me to be a principle upon which a man can load his gun with the greatest safety to himself, and can use it in the most expeditious manner. With regard to his application of hydraulics and pneumatics, it appears to me to be perfect. But I pronounce no opinion upon it. Probably, there are many gentlemen present who would like to ask some questions; and I have no doubt Captain Moncrieff will be glad to answer them, or, if there is any gentleman who would like to express his opinion upon the subject, it might be of service not only to Captain Moncrieff, but to ourselves as well, as we are all interested in the question, if he would express that opinion. Other gentlemen may have applied their minds to the same subject, and a hint from them may be of great value.

Captain WILKINSON, 16th Lancers: I should be glad to know if you are prepared to employ this new gun for land defences, as well as for sea defences? It seems to me to be an improvement even upon your first gun.

General Sir WILLIAM CODRINGTON: Perhaps Captain Moncrieff will explain how the gun is trained and laid, and also how the shutters are to work. Are they shot proof? and are there any other particulars proposed with regard to the shutters? which appear to me to be an important part of the system for naval guns.

Captain MONCRIEFF: This is not a very good representation of the shutters. Two or three different forms of shutters have been designed, those with counterweights are almost in equilibrium, but have a tendency to close. There are other shutters which are drawn together by the recoil of the gun. The method adopted for this purpose is the following: When the gun descends, the cross head passes down over two rods, which are made with a four-sided spiral. The angle of the spiral is very slow indeed at first. The gun goes down some distance before it acts on it at all; then it begins to act very gradually, and the screw goes on in increasing progression. That screw, or spiral, acts on a pinion, which draws the shutter over the port, and when the gun rises, it opens it again. When the port is closed, you can then walk over it as well as on any other part of the deck. With regard to the question about laying the gun, I propose, in this case, to adopt the same method that is now used with the turret, that is to say, to have man-holes and sights upon the revolving part of the deck. It will at once be observed, that if you lay this part of the deck, you also lay the gun just as you lay the guns by laying a turret. But you have the additional advantage at long range, and where shrapnel fire is not so severe as to make exposure of a man inexpedient, of being able to lay the gun with ordinary sights from the deck, as you would in ordinary practice from an open platform. As I have answered that question, I will now answer the first question with regard to the application of the gun for land defences. I beg to say that I have not yet applied the system to land defences; but I have no doubt whatever, that in some cases, it will be very well adapted for land defence, more especially in the detached iron forts which are used in the defence of Portsmouth harbour. There, I think, the new system might be applied with advantage. The more simple, better known, and readily used plan of counterweights, would, I think, be more suitable for ordinary works.

General Sir WILLIAM CODRINGTON: I do not quite understand about the training. Perhaps Captain Moncrieff will explain it. As I understand him, the training must be done from the deck, and the sighting from the deck, which would require two or three men.

Captain MONCRIEFF: The training of this gun is no more done from the deck than the training is done from the roof of a turret. The training is done below; and, as

I mentioned in my paper, it is done, if necessary, by means of steam power, which would generally be at the disposal of the vessels using this form of arrangement. Of course, it can also be done without steam. In the plan I have matured, the method of training is the following: Underneath this very small and compact carriage there is a toothed wheel, which is in gear with a pinion in communication with the engine. That pinion shaft is again put in gear for right or left action by means of a friction-cone. The gun can thus be trained to right or to left with the greatest nicety and precision by the mere movement of a lever by a slight pressure from the hand. That is the plan which I have matured. Others may, no doubt, be applied, but I imagine that an engineer will consider this method sufficient for the purpose.

Captain FIELD, R.N.: I think that your gun will have to be considerably higher than you now propose to place the axis of the piece, because, although you have designed shutters to cover that opening, any naval officer will, I think, tell you that those shutters will not be sufficient protection for the opening. Therefore you will require considerably higher combings, of 2 feet in height, and that will raise the axis of your piece 2 feet higher than it now is. It would not affect the principle at all, I admit. Then I want to know where the man is to be who shall fire the gun? You say the man can take his aim and fire the gun in the ordinary way. I cannot see where that man will stand. Either he must stand on the platform, and go up and down with the gun, where he will be in a perilous position, or he must have the means of ascending to the deck to fire the gun, and then of being able to step down again. It is clear he can hardly go up and down with the gun itself.

Captain MONCRIEFF: I shall be happy to answer the question. In this plan it is contemplated to have two manholes upon both sides of the gun, with a complete set of sights for both, so that the aiming and the firing can be performed from these manholes with sufficient protection to the men performing these operations. With regard to the observation about the height of the combing, sailors are the best judges of that. All I can say is, that it is possible to make the combing as high as may be required. A tarpaulin might even be left over the gun in the firing position. If the vessel is a low Monitor, it might be advisable to have a combing round the traversing part of the deck, to protect the port from water while it was open. In a vessel with a higher free-board, possibly that might not be required. But a combing can always be supplied with facility; there is no bar against its employment.

Captain JASPER SELWYN, R.N.: I have had the pleasure of being familiar with Captain Moncrieff's inventions since the first time that he brought them before this Institution, and even slightly before that. I have always, as is well known, been strongly impressed in their favour, but that would never make me deviate one iota from what I believe to be the most correct view of the last new invention, by whomsoever made. Now, in this instance, I think Captain Moncrieff has scarcely done himself justice in his explanation of the question, because he has omitted to show that this system admits of the raising of the gun to any possible height that may be necessary. If you wished to raise it 50 feet above the deck, it could be done; there is no difficulty whatever about it; the piston, which operates, would raise the gun to any extent that might be judged advisable. The length of the levers which support the carriage would be the sole measure of the rise of the gun. Secondly, the gun, as is well known to all those who have followed the modern system of pointing by deflection of the rays of light, can be efficiently pointed in almost all instances, except those of very close firing, by means of the mirrors, with even greater accuracy than can be obtained in any other way. The training can be done with perfect mechanical accuracy, such as we have never yet obtained by the use of handspikes, tackles, winches, windlasses, or any other contrivance which has yet been brought before us, since all these are subject to the hurry and confusion of an action, and to the possibility of a shot coming through a port, to which this gun-carriage is not subject. Captain Moncrieff has done himself justice, I think, but not more than justice, in the way in which he has pointed out the enormous advantages to be derived from the absence of useless weights. 275 tons of turret to protect one or two guns, means an addition to the weights to be carried by the ship, which is utterly unjustifiable. The turret is highly objectionable, on account of its position. It is still more to be

objected to by reason that, although we have had many experiments not devoted to the ascertainment of the particular question, we have never yet seen the effect of a single shot in stopping the revolution of the turret, when that shot was applied at or near what are called the combings of the deck. I entirely disagree with the gentleman who thought that high combings were a necessity with the shutters and the revolving apparatus of this gun. If they are so, then we certainly ought to have high combings, which we have not got in the turret vessels. If they are so, then all our knowledge of modern ways of keeping out water and of making close fitting joints are utter fallacies. I think the amount of leakage which might possibly come down from these shutters properly fitted, or from that revolving piece of deck, would be so insignificant, that no one need fear it, more particularly if the hydraulic propeller which Captain Moncrieff has spoken of be fitted to a ship. I believe it to be the very best thing of modern days, only waiting its advancement, as all useful inventions do wait theirs, for the ten years which usually elapse, and which have elapsed, since Captain Moncrieff first tried to force his invention on the attention of the public. That this gun will be valuable for small gunboats I have not the slightest doubt. It will enable us, for the first time, not to put all our eggs in one basket. We shall have an efficient coast defence, without being condemned to see useless hulks, which cannot go to sea, and are ill-adapted for coast defence, rusting to pieces in our harbours. We shall be able to have a mosquito fleet, such as Mr. Scott Russell has spoken of at the Naval Architects, which is infinitely more formidable to an invading foe, because it can be stationed at more points than the number of great unwieldy Monitors we could afford. But the second value of this gun-carriage is in the seagoing ships; and there it will have the value which we all accord to the greatest number of guns carried in the smallest tonnage. Gentlemen who have looked with admiration at the turret vessels, seem to have forgotten how many thousand tons are devoted to carrying how many guns. They have run away with the idea that, because the guns were of great weight compared with former ordnance, therefore it was a great achievement to carry six guns (I will take the outside number that has ever been proposed, not adopted, but proposed) on a vessel of something like 4,000 tons, which vessel would have carried six times the number of guns, aye, I might say twelve times the number of guns of greater weight collectively, throwing, it is true, a less formidable broadside at once, if single shots are taken into the account, but not a much less formidable broadside, if the whole of that broadside is directed to one spot, as gunners know well how to do it. It is a remarkable fact, to which I have before adverted in this Institution, that our experiments in concentrated firing upon armour plates have always missed fire. Somehow or other all the guns which were directed in a concentrated broadside on a target—take six or seven guns as the outside—out of those six or seven guns, perhaps three would miss fire. Well, we do not get—everybody knows we do not get—any measure of results. I hope we may not be dreadfully disappointed when we do get them. But it is certain that whatever gives us the power not only of carrying a greater number of guns, but of carrying equally heavy guns in greater number, is an admirable invention, even if it did not also enable us to carry those guns at sea as low down as it may be convenient for the vessel's capacity to carry them, and perfectly protected without special armour for the purpose. This invention of Captain Moncrieff does do that. I think it is a most admirable invention, and I think we may fairly trust the genius which has given us so great an improvement in our land gun-carriages, which all the world has acknowledged, to give us something for the Navy, which we have long been seeking for, which will give us the means to enable the last man left on board to fire the biggest gun in the ship.

The CHAIRMAN: If no other gentlemen has any observations to make, I beg to return our best thanks to Captain Moncrieff for his lecture, and to wish him success in the cause which he has undertaken.

APPENDIX.

(Copy.)

From General Sir J. L. A. Simmons, K.C.B., R.E., &c., &c.

Woolwich,
4th September, 1869.

Dear Captain Moncrieff,

I have been thinking over the plan you have struck out for mounting guns on board ship, so that, as with your carriages on land, they may fall on being fired, and be concealed below the deck, only to rise again, after being loaded, at the moment when their fire is to be delivered.

The manner in which you accomplish this, by storing up the power generated by the explosion of the gun, without the use of counterweight, as in the carriage invented by you for land service, is most ingenious; it is, at the same time, very simple, will require very little space, and is, in my opinion, sure to succeed, even with the heaviest guns.

The method of utilizing the recoil to compress air, through the agency of water, in the manner proposed by you, thus disposing altogether of the principle you have hitherto adopted of using a counterweight, gives you a power of raising and lowering the gun, by which, I believe, as you say, the heaviest gun will be worked with the same facility as a light gun, except as regards the actual loading, or handling of the charge and projectile.

I concur with you also in thinking that this new contrivance of yours will be capable of most useful application in other ways, and especially in substitution for the water buffer now applied on traversing platforms for checking recoil, although I dare say you will not press its application much in that way, as you are such an enthusiast, you would like to see all guns mounted, so as to rise and fall; but any contrivance which will bring recoil under control for guns firing from casemates, or through portholes, is most valuable, and I trust you will not lose sight of its application in this way, but will press it also upon the Government.

I cannot close this, however, without congratulating you most heartily on your discovery, which will, I firmly believe, produce a great change in our ships of war. It will, I suspect, dispose of the much-vexed turret question, as I cannot conceive that a revolving turret weighing probably 300 tons, exclusive of guns and the machinery to turn it, will ever be adopted, when you can have the power of revolving a gun on a simple turn-table, under the protection of the deck and the armoured sides of the ship. Turrets also have yet to be tried in action. An American who had been in one in action described the effects to me as very formidable; the noise and reverberation caused by a shot striking the turret was most stupefying, and had even killed men inside, without injuring the turret, by the mere concussion of the blow. And then, again, where there is such a heavy mass to move, there must always be a chance of its going wrong, especially when struck; whereas with your invention, the mass to be moved is comparatively light, and is not similarly exposed.

* * * * * * *

Wishing you a speedy success in obtaining an experiment from the Admiralty,

Believe me,

Yours very faithfully,

(Signed) J. L. A. Simmons.

The following is an approximate estimate of the price per gun of works and of ships:—

1st. Works of the most expensive kind, such for instance as—

	Cost per gun.
Horse Sand Fort, with ten 25-ton guns, twenty-four 18-ton guns, and twenty-five 12-ton guns	£8,890

	Cost per gun.
Spit Bank Fort, with four 25-ton guns, nine 18-ton guns, and six 7-ton guns	10,900
Portland Breakwater, with fourteen 18-ton guns, and fifteen 12-ton guns	9,500

Average price per gun, £9,600.

2nd. Forts, with granite casemates and iron shields, such for instance as—

Gilkicker Battery, with five 25-ton, seventeen 18-ton, and five 12-ton guns	3,700
Garrison Point Battery, with thirty-six 12-ton guns ..	4,200
Bovisand Battery, with fourteen 18-ton and nine 12-ton guns	3,800

Average price per gun, £3,900.

3rd. Earthen batteries, without iron shields (the addition to these shields would increase the price about £1,300 per gun) for instance—

Southsea Battery, with one 25-ton, twenty-two 12-ton, and nine 7-ton guns	1,270
South Hook Battery, with five 12-ton, and fifteen 7-ton guns	2,290
Warden Point Battery, with four 12-ton, and four 7-ton guns	1,600

Average price per gun, £1,750.

4th. Ships of war, unarmoured and lightly armoured, such for instance as—

"Staunch," gunboat, with one 12-ton gun	6,000
"Inconstant," unarmoured frigate, with sixteen 12-ton guns	13,000
"Caledonia," with 4½ inch iron plating, eight 6-ton guns, six 110 prs., and twelve 68 prs.	11,500
"Royal Sovereign," turret ship, with 5½ inch iron plating, and five 12-ton guns	40,000

Average price per gun, £14,500.

5th. Ships with heavy armour, such for instance as—

"Sultan," with plate from 9 to 6 inches, and twelve 12-ton guns	31,000
"Devastation," turret ship, with plate from 12 to 10 inches, and four 12-ton guns	69,000
"Glatton," turret ship, with 12 to 10 inch armour, and two 12-ton guns	84,300

Average price per gun, £45,000

These averages are not struck alone from the instances given.

Gun for gun, the armament of vessels, is much more expensive than that of works; but it will be borne in mind that ship armament is more valuable than that of forts, owing to its mobility. A gun which can be brought into action at say ten different points within a radius of fifty miles, and in a given time, is so much more formidable to an enemy than one which is stationary. This argument applies in the same manner to guns stored at railway termini with lines radiating to coast positions, provided they can be mounted where most required, within a given time (see p. 402.)

The advantage of employing small vessels for coast defence is suggested by the price of the "Staunch," given in the above tables; and the rapid development of the art of defence by torpedoes or submarine mines, is the argument against large vessels whenever they can be dispensed with; size, however, is necessary to obtain speed.

The problem to be solved is, *What form of war-ship will combine in itself, the greatest economy, sea-going qualities, and power of offence and defence?*

If the suggestions at page 410 are successfully carried out, which they now can be without risk of failure, and at an expense insignificant when compared with the prices in the last table, the country will then possess a proved system that will render it possible to build vessels with heavier armour than any now afloat; which will be as good sea boats as any unarmoured vessel; and which will carry the heaviest artillery our arsenals can produce.

Every one of the above conditions are now within reach; and I am assured by the best authorities in England that an actual speed of 15 knots can be given in addition to them.

It is unnecessary to compare a vessel of such qualities with the best now afloat. When it may be stated that this country can obtain the means of mounting the heaviest artillery in ships with an all-round fire without revolving turrets; of a propelling power that will both drive a ship at high speed, and prevent her from sinking if injured in action; and of designs that will make a war ship not only the best sea boat, but in action the strongest monitor, I earnestly submit that at any rate the first step should be taken by a great maritime nation like England, to verify the truth of such statements, and to encourage any person who ventures to bring them forward with sufficient evidence as to their complete success.